

Fishery management options for Lesser Antilles countries

(Antigua and Barbuda, Barbados, Dominica,
Grenada, Saint Kitts and Nevis, Saint Lucia,
Saint Vincent and the Grenadines)

by

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PREPARATION OF THIS DOCUMENT

This paper reports on a Technical Cooperation Programme (TCP/RLA/6774) undertaken in cooperation with the Governments of the Member States of the Organization of Eastern Caribbean States, and reported in preliminary form as Field Document 4 of the above project in January 1989. The need for this programme was suggested by the Lesser Antilles Committee of the Western Central Atlantic Fishery Commission (WECAFC), and is an outgrowth of earlier FAO activities in the region, namely, the Consultation of Shared Fishery Resources of the Lesser Antilles, held in November 1986 in Puerto Rico (FAO Fisheries Report N° 383), and an earlier FAO initiative relative to harmonization of fisheries Legislation of the Island States of Eastern Caribbean. The considerable interest of the conclusions of this study for other (particularly island archipelagic) States, suggests that this report is of more general interest to other regions of the world.

ACKNOWLEDGEMENTS

This report, and the project from which it resulted, has depended on the support and commitment of many individuals. Most significantly, Wayne Hunte, of the Bellairs Research Institute, deserves special thanks for his sustained interest and enthusiasm for this activity. Through extensive review of the manuscript, and lengthy discussions on all topics covered here, he contributed substantially to this project. The Fisheries Officers and other Fishery Division Staff from the participating islands contributed their time and energy freely. Other individuals who were enthusiastic and supportive were: Miguel Rolon of the Caribbean Fishery Management Council, and Gregg Waugh of the South Atlantic Fishery Management Council, who freely contributed their knowledge of the management planning process in the US; Richard Appeldoorn, of the University of Puerto Rico who reviewed drafts of the lobster and conch plans, which made liberal use of his publications on those species, and Daven Joseph of the Organization of Eastern Caribbean States (OECS) Fishery Unit, whose recognition of the importance of this project was a motive force.

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ABSTRACT

In general, island shelf resources (lobster, conch, reef fish) are either fully exploited or overexploited. Sea urchins are an exception with some, but unknown, scope for development. Optimizing the returns from these resources will require careful husbandry. The problem with these fisheries will be ensuring that management inputs do not exceed potential outputs. This may often require the use of simple, commonsense measures. Wherever possible, management of coastal resources should be vested in the users, with assistance from Government. This will free valuable manpower for management of the offshore resources.

Offshore resources mainly tunas, and swordfish appear to hold some, though unknown, scope for development. These are the least known resources, and taking advantage of their potential through commercial fleet development will require economic risk taking and technical expertise. The appropriate technology for harvesting these pelagics may well be small-scale. Although potentially valuable, the net worth of these resources to the islands of the region is probably not large enough that we can afford to neglect the resources of the island shelves in attempting to realize this potential. Management must consider the full suite of resources, and allocate management effort according to the value of each.

There is not a long tradition of fishery resource management in the Lesser Antilles, and the region is not particularly well equipped to start now. There are severe institutional limitations, limited expertise, and minimal data on which to base fishery management strategies. Consequently, the prominent recommendation in most plans is for better information -- data gathering of many types. Information required to evaluate the feasibility of community-based management for coastal resources is particularly lacking. Such approaches work well in many instances in the south Pacific and southeast Asia. However, eastern Caribbean social structures and cultural traditions differ from theirs, and finding the right approach to community-based management will require considerable focused effort.

The plans are not all research recommendations. There are many actions which could be taken now based on available information and commonsense. Since the coastal resources are often overexploited, these actions usually involve regulating fisheries in some way. Such action is difficult to implement, but is essential if the long-term potential of the entire resource spectrum is to be realized for the benefit of the people of the region. Wherever possible, a neutral approach has been recommended: regulate at the current status and reduce fishing effort by attrition over time. However, some measures demand a sterner approach. If blatantly destructive practices, such as dynamiting, trap poaching, egg scrubbing on lobster, cannot be controlled, it will be very difficult to gain the cooperation of honest fishermen, which will be essential for serious fishery management in this region.

PREFACE

The need for Fishery Management Planning in the Lesser Antilles has long been recognized. At the country level, Fishery Management Plans (FMPs) are required by the Organization of Eastern Caribbean States (OECS) Harmonized Fishery Legislation, and the Draft Fishery Legislation of Barbados. At the subregional level, the degree of resource sharing identified by the FAO Expert Consultation on Shared Fishery Resources of the Lesser Antilles, Mayaguez, Puerto Rico, November 1986, made it obvious that a considerable degree of cooperation would be required to manage the resources of the subregion.

The need for subregional cooperation in management, and for local and subregional fishery management plans was raised by the FAO WECAFC Committee for the Development and Management of Fisheries in the Lesser Antilles, at its third session in Martinique, July 1987. This project was formulated on the recommendation of that Committee. More specifically, the project was conceived to assist the Organization of Eastern Caribbean States Fishery Unit in its mandate to develop fishery management plans for Member States and for the OECS region. These Fishery Management Plans are required by the harmonized legislation, which has now been enacted in all States. Barbados, which is also a participant in the project, is in the process of enacting similar legislation. Barbados and the OECS States have similar or shared resources and similar management requirements.

The Fishery Management Plans which were developed in this project are perceived as being important for several reasons:

- (1) They provide a point of reference for continuity in a changeable political and administrative environment.
- (2) Their preparation and review promotes discussion of fishery management concepts and requires evaluation of approaches.
- (3) They provide a way of informing local and international agencies of the status and direction of fisheries management, thus indicating where they can contribute, and how they can harmonize their activities with fisheries objectives.

Although much of the short to medium term action required for implementation of the plans will require the allocation of additional resources to Fishery Divisions in the region, there is a great deal that can be done now with existing resources. It is hoped that by providing a comprehensive and rational framework for fishery management in the subregion, this project will have provided the impetus for action.

The Project was carried out by Dr Robin Mahon, FAO Fisheries Resources Specialist, under the auspices of the WECAFC Lesser Antilles Committee, and the guidance of a Working Group with the following membership:

Dr W. Hunte, Director, Bellairs Research Institute, and Senior Lecturer, Biology Department, UWI, Barbados;

Ms F. Darroux, Data Management Officer, OECS Fisheries Unit, St. Vincent;

Mr P. McConney, Fishery Officer, Fisheries Division, Ministry of Agriculture, Bay St., Bridgetown, Barbados;

Mr K. Morris, Chairman, WECAFC Lesser Antilles Committee, and Senior Fisheries Officer, Ministry of Trade, Industry and Agriculture, Kingstown, St. Vincent;

Mr M. Rolon, Caribbean Fishery Management Council, Hato Rey, Puerto Rico;

Mr G. Waugh, South Atlantic Fishery, Management Council, Charleston, South Carolina, USA, and Director, Gulf and Caribbean Fishery Institute, Charleston, South Carolina.

The Vice-Chairman of the WECAFC Lesser Antilles Committee, Dr D. Hery, Administrateur en chef des Affaires maritimes, Direction régionale des affaires maritimes, Martinique, was invited to be a member of the Working Group but was unable to participate in its activities.

The sequence of activities in the project was as follows:

Step 1: Preparation of the Management Options document: The purpose of this document is to present the possible approaches to management of the important fishery resources in the region. The revised version of this document comprises Section 1 of this Field Document.

The basic content and format of the document was developed by the Working Group in May 1988. The document was prepared by the Fishery Resources Specialist and reviewed by the Working Group.

Step 2: Identification of options by participating islands: The Management Options document was then sent to the participating islands in August 1989, for review and for the identification of feasible and appropriate options in each island.

Step 3: Compilation of common ground with regional implications: The last step in the process was to review the options selected by participating islands, and to combine those which require regional action. This was done at a workshop. The participants at the workshop were representatives from participating islands, and the Working Group. The Workshop took place in November 1989, and the Workshop Report comprises Section II of this Field Document.

The Management Options document (SECTION I) is written for three sets of readers, and organized so they can easily access the information they will need.

Part 1 presents the working principles on which the fishery management options are based.

Part 2 reviews approaches to fishery management, specifically from an eastern Caribbean perspective.

Part 3 is the backbone of the Management Options document. It begins with a brief consideration of the institutional aspects of implementing management.

This is followed by executive summaries of the resource specific options, with recommendations. Finally, there are the resource specific sections (e.g. lobster, flyingfish). Each consists of two parts: the Management Plan, and Supporting (Technical) Information.

The envisaged sets of readers are:

- (1) Fishery Officers and other fishery professionals who will need to consider the entire document, including supporting material in order to evaluate the options.
- (2) Administrators with direct line authority for fisheries (Permanent Secretaries and Directors of Agriculture/Fisheries), and responsible members of the fishing industry who are participating in management decision making. These individuals will probably need to consider Parts 1 and 2 in total (13 pages), the beginning of Part 3, and the Management Plan for each resource.
- (3) Senior policy makers, who will be adequately served by reading Part 1, the beginning of Part 3, especially the resource specific summaries, and hopefully, Part 2.

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SECTION I: FISHERY MANAGEMENT OPTIONS FOR THE LESSER ANTILLES

PART 1: GENERAL PRINCIPLES AND OBJECTIVES

BACKGROUND

This Management Options document is the first step toward the national fishery management plans required by the OECS Harmonized Fishery Regulations, and by the draft Fisheries Act of Barbados. By identifying the aspects of fishery management requiring action at the regional level, it is also a step toward a regional plan which complements the individual island plans.

These plans follow from, and should be consistent with the UNCLOS III^{1/}. In particular, the following interpretations^{2/} of UNCLOS III are directly relevant to the development of the management plans.

"The Convention of the Law of the Sea gives coastal States sovereign rights over the resources of the exclusive economic zone (article 56), [..and...] it is the sole prerogative of the coastal State both to determine the allowable catch of the living resource in the EEZ (article 61), and to determine its own capacity to harvest those resources (article 62)."

"One of the main duties of the coastal State is to ensure that 'the maintenance of the living resources in the exclusive economic zone is not endangered by overexploitation'. Toward that end the coastal State has to adopt proper conservation and management measures (article 61).

"Where the coastal State does not have the capacity to harvest the entire allowable catch, it has the duty to give other States access to the surplus of the allowable catch."

"The Convention provides for States to take measures in order to co-ordinate and ensure the conservation and development of stocks where 'the same stock or stocks of associated species occur within the exclusive economic zones of two or more coastal States'. [...] States may utilize appropriate subregional or regional organizations in seeking to agree upon measures to be taken."

"The coastal State and other States whose nationals fish for highly migratory species both within and beyond the exclusive economic zone are under a duty to co-operate to ensure conservation and promote the objective of optimum utilization of such species."

1/ United Nations, 1982. The Law of the Sea. Official text of the United Nations Law of the Sea with annexes and index, final act of the Third United Nations Conference on Law of the Sea. New York, United Nations

2/ FAO, 1986. The Fishery Provision of the UN Law of the Sea Convention. FAO/WECAFC/CARICOM Workshop on Fisheries Legislation in Caricom Member States, Barbados, 1986, Doc. Ref. WP/3: 14 p.

The above provisions, and the management options presented in this document, are based on the conclusion that it is necessary to actively manage fishery resources. This in turn is based on the assumption that an open access resource will eventually become overexploited. Thus it follows that for optimal long-term utilization, fisheries will require regulation and should be regulated provided that returns (not necessarily only economic) justify expenditures.

BASIC PRINCIPLES OR STANDARDS

The management options presented in this document have been based on the following principles.

1. Management measures shall^{1/} prevent overfishing^{2/} while promoting the optimal sustainable utilization^{3/} of each resource.
2. The resource belongs to all the people of the country and is to be managed for their benefit. A properly managed fishery will make best use of public funds.
3. Management will be most effective if initiated during development of the fishery rather than introduced after overexploitation and overcapitalization.
4. The responsibility for management should be shared by the Government and the fishing industry which makes its living from the resource. All components of the fishery sector should contribute to fishery management planning.
5. Management should be based on the best scientific information available^{3/}.

- 1/ Overfishing is here intended in the broad sense as fishing beyond any point agreed upon as appropriate for optimal sustainable utilization. Overfishing is more fully discussed in Part 2
- 2/ The concept of optimal sustainable utilization has gradually replaced that of maximum sustainable yield (MSY) over the past 15 years (Roedel, P. 1975. Optimum sustainable yield as a concept in fisheries management, American Fisheries Society Special Publication No. 9). The idea of an optimum rather than a maximum makes it possible to allow for objectives which are difficult to quantify. For example, to set catches some arbitrary amount below MSY in order to reduce the risk of stock collapse
- 3/ The intent here is that management should use whatever scientific information is available, although it may be incomplete, or qualitative. Frequently, management based on preliminary information must be tempered to allow for its tentative nature. Such adjustments may favour the resource, or the fishing industry, depending on circumstances. Use of the word 'scientific' is intended to exclude personal preferences and unsubstantiated opinions

6. To the extent practicable, an individual stock of fish should be managed as a unit throughout its range. Thus it follows that shared, or interrelated stocks should be managed as units or in close coordination^{1/}.

7. Management and conservation measures should, where practicable, minimize costs and avoid unnecessary duplication.

THE OBJECTIVES OF MANAGEMENT

Fishery management plans often state the following objectives:

- (i) Maximize catch for food
- (ii) Maximize economic returns (profit)
- (iii) Provide foreign exchange
- (iv) Provide employment
- (v) Increase the availability of large fish for sport fishing
- (vi) Conserve marine habitats and marine life for tourists

Trade-offs are to be expected between these objectives^{2/}, which would vary among countries and fisheries. For example, profitability is usually

1/ Stocks may be shared by countries in a variety of ways, e.g., stocks straddling the EEZ boundary, seasonal or other migrations, dispersal or mixing of eggs and larvae. These were reviewed at the Expert Consultation on Shared Fishery Resources of the Lesser Antilles Region (Mahon, 1987 [ed.]. FAO Fisheries Report No. 383), where the major resources were categorized according to the type and extent of sharing expected, and where most resources were found to be shared in some way

2/ Following is a matrix indicating the compatibility of the objectives listed.

	Max. econ.	For. exch.	Employ- ment	Sport fishing	Tourists
Maximize food	No	ST	Yes	No	No
Maximize econ.		Yes	No	No	No
Foreign exchange			ST	?	No
Employment				ST	No
Sport fishing					Yes

'No' and 'Yes' indicate objectives which are incompatible and compatible respectively, the extent of which varies from one combination of objectives to another. 'No' for the combinations of Foreign exchange and Employment with Tourism refer to the benefits in those categories derived from fishery resources, rather than from the enhancement of the tourist industry. 'ST' means sometimes, for example, whether harvesting of conch or lobster is highly labour intensive, or mechanized and cost efficient should not affect the returns from export of the product. In reef fish fisheries however, maximum employment may occur at a level of effort where exportable species have been depleted. The foreign exchange value of good sport fishing is unknown. Maximizing food may influence the balance of foreign payment if imports are

maximized at a lower total catch than the maximum which the stock can yield^{1/}; and the interests of sportfishermen, who target predatory species, are in conflict with those of commercial fishermen, who usually exploit the prey of those predators.

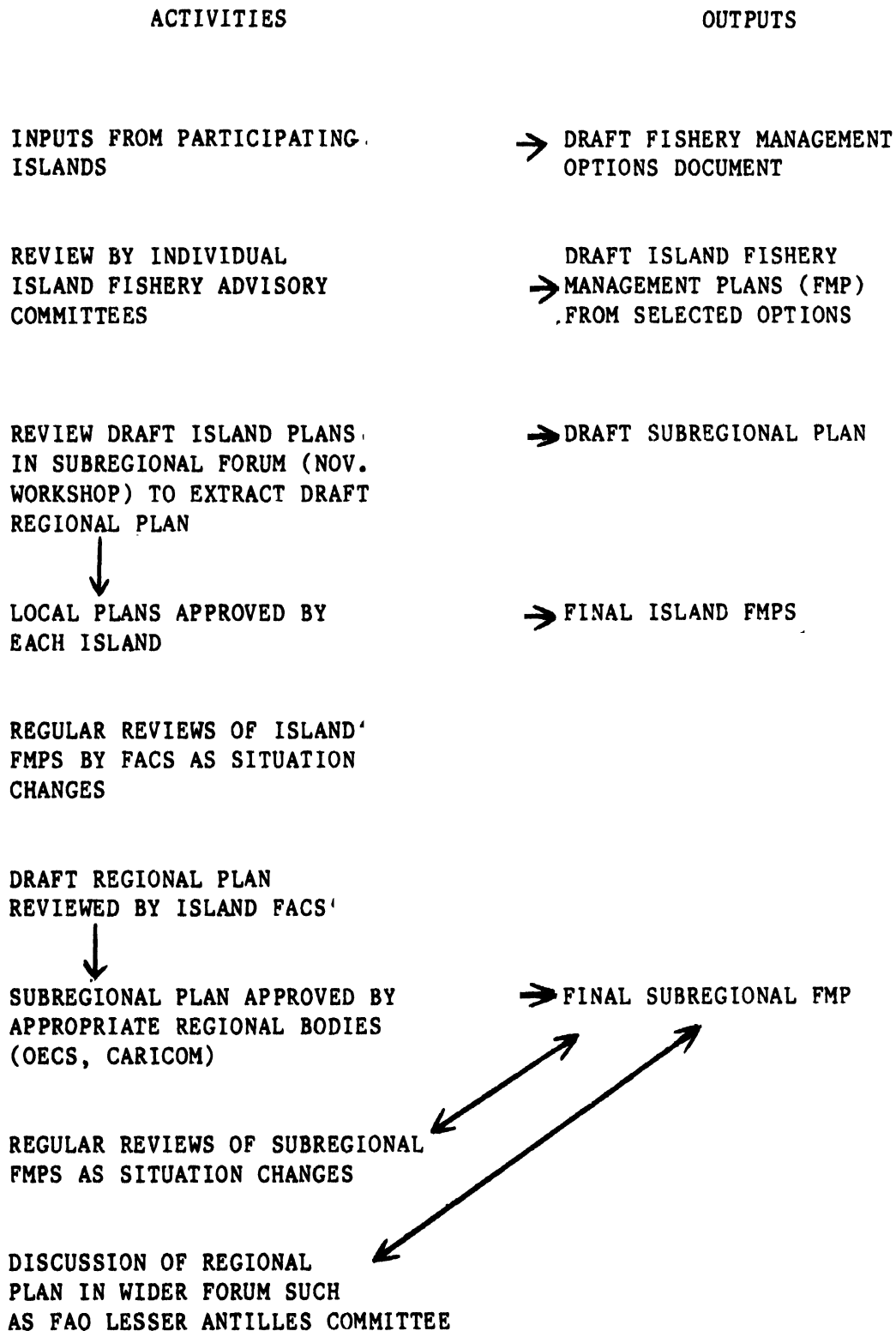
Fishery management must take account of unpredictable fluctuations in resources, and of inaccuracy in measuring critical variables. Although these characteristics reduce the feasibility of achieving precisely set objectives, new concepts of "risk associated with particular objectives" are taking an increasingly prominent place in determining fishery management objectives.

Global experience has shown that the risk of sudden stock collapse to problematically low levels, increases with the level of exploitation. In response to this risk factor,^{2/} fishery managers in many countries now routinely incorporate a "safety margin"^{2/}.

- ^{1/} Most of the arguments relating to these objectives are based on the simple bioeconomic model which assumes that as total fishing effort increases, total yield first increases to a maximum then declines, reaching zero when the stock is extinct. Total fishing costs increase steadily throughout
- ^{2/} Safety margins, such as fishing at 2/3 the estimated effort needed to catch the MSY, or at $(F_{0.1})$ less than the fishing mortality required to get the maximum yield per recruit, are widely used in most places where management is based on quantitative assessments

THE FISHERY MANAGEMENT PLANNING PROCESS

The following process is suggested for preparing, reviewing and implementing fishery management plans at the local and subregional level. Note that this document is the first output in the process.



PART 2: GETTING DOWN TO MANAGEMENT

INTRODUCTION

This part of the Fishery Management Options document briefly reviews conceptual and practical approaches to fishery management. The purpose is to establish a common understanding of these issues before considering the resource specific management plans. Detailed treatments of fishery regulation tools can be found in reports such as Beddington and Rettig (1984), and the Expert Consultation on the Regulation of Fishing Effort (FAO, 1983).

Four concepts which are important to management will first be reviewed. These are overcapitalization, overfishing, multispecies fisheries, community based management, and shared resources.

Overcapitalization

When the harvesting capacity of the fleet exceeds the amount of resource available for harvest, the fishery is overcapitalized. The term is usually applied to commercial fleets which require significant capital, and are therefore a long term investment. These units cannot afford to stop fishing if stocks become depleted, and may continue to fish even while losing money in order to service their loans. In the extreme, the amount of resource available to individual fishing units (boats, divers) becomes too small to meet operating costs and some units must cease fishing, often with disastrous socioeconomic effects.

Overcapitalization is typically the result of rapid development without adequate information on available yields from the resource. However, even with good information on available yield, and regulations limiting total catch to that yield, fisheries may become overcapitalized. Indeed, limiting catch alone may lead to a race for the catch and actually promote excess capacity. The problem of overcapitalization is more fully considered by Clark (1985) among others.

Overfishing

Broadly, overfishing occurs when catches exceed the level considered desirable for achieving the stated objectives. More specifically, overfishing usually refers either to recruitment overfishing, where there are not enough mature fish left to replenish the stock, which therefore declines, or growth overfishing, where fish are caught too small, before they have completed their rapid early growth, and yield is therefore lost. The two types of overfishing are related in that catching fish at a small size usually means that they do not reproduce before being caught, and the capacity of the stock to replenish itself is diminished.

A more recently recognized type of overfishing in multispecies fisheries is community or assemblage overfishing, where increasing fishing mortality results in a decreasing proportion of larger, usually more valuable species in the catch.

Multispecies problems

Most of fishery assessment and management theory currently in practice is based on the population dynamics of single species. In reality, most fisheries, especially tropical artisanal fisheries, exploit more than one species. Taking the possible interactions into account greatly complicates the task of stock assessment and fishery management. Two types of interaction can be recognized. The first is Technological interactions, where different species are taken by the same gear. The major problem in managing such fisheries is that regulations which are appropriate for some of the species may not be so for others. This requires a compromise approach in which some species may be overexploited and others underexploited (see community overfishing above).

The second type of interaction is Biological interaction, where the abundance of one species is affected by that of another species. This may occur through a predator-prey (or disease-host) relationship, through competition between species, or a combination of the two. Depending on the relationship, exploitation of one species by the fishery may affect the potential yield of the other species. For example, heavy exploitation of flyingfish, a common prey of large pelagic fishes, may reduce abundance and hence yield of the latter. Estimating the extent and influence of these interactions is very difficult. Fishery biologists are only now beginning to address these problems.

Community based management

Community involvement in fisheries management can be taken to the extent of vesting the responsibility for the management of resources in the community which utilizes them. This can be achieved by allocating or leasing fishing rights to social units (families/communities) fishing various tracts of water. The approach is most applicable to small-scale, artisanal fisheries utilizing resources adjacent to the community.

Johannes (1978) describes a variety of traditional methods of renewable resource conservation which were commonly practiced in the Pacific Islands, but which have been largely eroded by the imposition of western culture. Such traditions do not appear to be common in Caribbean islands. Possible reasons are that the populations in the Caribbean are relatively new, compared to those of the Pacific Islands, that communities are quite differently organized, and that western influences are entirely pervasive in the Caribbean. The north coast fisheries of Jamaica appear to be an exception where the shelf fish resource is partitioned among the fishing communities along the coast (Berkes and Shaw, 1986).

Attempts to introduce or encourage community based management in the Caribbean region will need to consider the socioeconomic characteristics of the region and the feasibility of adapting Pacific models to the local situation. For example, community hierarchies are less well established in the Caribbean, and community based fishery cooperatives may be the socio-economic unit which must be considered.

This complex and little researched subject may be of great significance in management of coastal resources in the Caribbean region. In coastal resource management can be largely vested in communities or cooperatives, valuable human and fiscal resources could be released to manage offshore resources.

Shared resources

Many fishery resources either straddle, or migrate across boundaries between EEZs (Caddy, 1987). These present special problems for fishery management in that mechanisms for cooperative management must be established among the countries which share the resource. In the Lesser Antilles region, most, if not all, resource types may potentially be shared between two or more countries (Mahon, 1987). For demersal species, sharing may be restricted to islands with a common island platform. However, possible recruitment effects due to dispersal of planktonic early life history stages between island platforms may prove to be significant. For pelagics, the extent of sharing may range from the island shelf situation for coastal pelagics, to ocean wide for large migratory species, such as yellowfin tuna.

APPROACHES TO MANAGEMENT

There are many fishery management tools which can be used to regulate fisheries, and the use of these tools in various combinations to achieve specific objectives can be considered as the fishery management strategy. Regardless to the strategy, there are certain basic requirements for management which are considered first.

Basic requirements

Licensing and registration

It is useful to distinguish between licensing and registration in the following way. Registration is the process of enumerating fishing units, either for information purposes, or to ensure that they meet certain criteria such as safety standards. A licence is permission to fish according to the specifications of the licence. A licence may be denied or approved according to certain fishery objectives such as effort limitation. Both registration can, but need not necessarily be, a source of revenue if a fee is charged.

Virtually all management approaches require, or would be facilitated by, the registration of fishing units. Several management approaches depend on the issuance of licences at regular intervals. Apart from the role of registration and licensing in regulation of fisheries, the process provides essential data on fishing effort, and can be a source of revenue from the fishery.

Monitoring

Regular or periodic monitoring of the performance of the fishery sector is essential to the effective application of management tools, and is the only way that the impact of implementing any approach can be evaluated. Minimum requirements are estimates of catch and catch per unit effort by fishery type.

Basic plans for the establishment of fishery monitoring systems in Lesser Antillean islands are available in the Proceedings of a workshop held in Barbados in June 1987 (Mahon and Rosenberg, 1988).

Community involvement

Perhaps the most important principle to emerge and gain credence in the 1980s is that for any fishery management measure to be successful, it must have majority support in the fishery sector (Pringle, 1985; Regier and Grima, 1985). The implications of this principle are considerable, as it demands:

- (1) that the fishery sector be educated as to the purposes, pros and cons of options;
- (2) that the fishing industry be consulted as management plans are being developed; and
- (3) that the industry be kept informed of progress in the implementation phase of any approved management plan.

This gives considerable emphasis to the role of extension programs in fishery management. Johannes (1981) provides useful insights into the problems and benefits of working closely with fishermen in tropical coastal fishing communities.

Fishery management tools

The regulation of fisheries generally proceeds along either or both of two major avenues.

The first avenue is the limitation of the amount or size of fish caught, either directly or indirectly, in order to protect the resource, or maintain it at some level of abundance best suited to the stated management objectives.

The second avenue is to regulate the way in which the catch is taken, in order to promote economic efficiency (e.g., prevent overcapitalization), or to direct the development of the fishery along a path which is most likely to produce the stated objectives (e.g., exclude industrial fleets to benefit artisanal fishermen).

The more common tools used to regulate fisheries are described below.

TAC (total allowable catch) regulation

This is the most complex, data intensive approach. In its fullest form, the abundance of the resource is estimated, and the potential yield at some desired target fishing mortality or effort is calculated. The TAC is based on this yield but may be higher or lower depending on a variety of social, economic, and political factors.

Data and analysis requirements for this approach are usually substantial. In the case of general/surplus production modelling, time series of catch/effort data are typically required for 7-10 years. However, an approach suggested for reef fishes is an exception in which catch and effort data from several areas rather than years are used. In the case of analytical modelling, total catch, and age or size composition of the catch are required for a similar time period, as well as some index of abundance, such as provided by a standard survey or by catch per unit effort. Sampling for detailed biological data, and fishery independent surveys are expensive. The

analysis and interpretation of the resulting data, and translation of the output into management advice requires a range of skills and experience not usually found in a single individual.

Where the abundance of the resource fluctuates due to variability in recruitment, as appears to be characteristic of Caribbean pelagic fish stocks, TAC assessments will be required at regular intervals, perhaps even annually.

One practical short cut to estimating TAC is to use past catches as a guideline. The TAC can be made larger or smaller than past catches depending on whether the resource is considered overfished or underfished.

Surveillance and enforcement requirements of this approach are also usually expensive. There must be the capability of continuous monitoring throughout the fishing season, and of closing the fishery when the allowable catch has been taken.

Management by TAC does not prevent overcapitalization of the fishery, and may even encourage it if there is intense competition for a small TAC.

Effort control by limited entry

Effort can be directly limited to a desired level by requiring that fishermen or boats be licensed in order to fish, and by controlling the number of licences which are issued. The licence system is useful in its own right because: (1) it can provide an important source of data on the fisheries at relatively low cost (e.g., the licence application form can include data on the fisherman and the boats; and (2) by charging a licence fee, it can provide revenue to cover administrative costs.

The licence system can also be used to regulate access by means of market forces if fishermen are allowed to sell their licences on the open market if withdrawing from the fishery. The advantage of this approach is that fishermen selling licences will realize their value and new entrants will be determined by the market, not by other means such as inheritance, or chance.

Data and analysis requirements of limited entry in its most complete form include some estimate of the potential yield of the stock, and some estimate of the fleet and processing capacity required to handle this yield. The capacity of the fishery is then directly limited to the size appropriate to the estimated yield.

When a fishery is known to be overexploited, but active elimination of fishermen is not politically or socio-economically acceptable, one option is to license all existing fishermen, then not issue any new licences until an appropriate number of units has retired from the fishery. With monitoring of the resource, licences can again be issued when the resource has recovered to an 'acceptable' level.

Surveillance and enforcement is based on the issuance of licences, and is less difficult than TAC regulation, if the fishery is not too diffuse, and if vessels are required to clearly display licences. The major problem with this approach, is devising an equitable system of determining who can or cannot fish. Furthermore, under effort limitation, the fishing power or capacity of individual units tends to increase, unless size, gear, horsepower, etc., are also regulated. Experience has shown that the fishing industry is adept at getting around effort regulations. Lastly, with a fluctuating resource, there will be overcapacity in the fishery in poor years and undercapacity in good years.

Size limits

Minimum-size limits are a common indirect means of limiting catch. They may be aimed at preventing recruitment overfishing, if the size is set so as to allow the organisms to reproduce before they are harvested, or at growth overfishing, if the minimum size allows the fish to realize their growth potential before being harvested.

In theory, size limits allow for the harvest of all individuals above the size. They typically assume that there will be a significant number of individuals above the size limit. When there is sufficient fishing effort to actually harvest most individuals above the size limit, size limits may have to be increased in order to maintain an acceptable spawning stock biomass, or alternative approaches employed.

Data and analysis requirements depend on the aim of the regulation. To protect against recruitment overfishing, information on size at maturity, on reproductive outputs at various sizes and on breeding behaviour is required. Depending on the population characteristics (e.g., the number of eggs produced and their survival) it may be necessary to allow several seasons of reproduction before the organism is harvested. With regard to growth overfishing, information on growth and mortality patterns is required.

Surveillance and enforcement requirements are self evident, and can be extensive for a widely dispersed artisanal fishery. In the case of high priced products mainly for export or restaurant consumption the onus can be placed on the purchaser.

Gear limits

Since the size of fish caught is closely related to the characteristics of the gear (e.g., mesh size or hook size), gear limits are an indirect way of controlling the size of fish caught. Gear limits may be easier to enforce than direct size limits. An additional advantage is that they reduce the need for discarding of undersized fish at sea, and the associated mortality.

Data and analysis requirements are similar to those for size limits above, but in addition, it is necessary to know the relationships between the gear characteristics and the size of fish caught. A problem with gear limits in multispecies fisheries (e.g., trap fisheries) is that several species are caught together and these may have different appropriate minimum size limits.

Surveillance and enforcement is generally easier than for size limits, as gear can be checked at less frequent intervals than catch to ensure compliance.

Closed areas and seasons

It may sometimes be desirable to exclude the fishery from areas where the organisms gather to reproduce, to provide for an unfished reserve of the resource, or to close the fishery during the reproductive season. These measures will generally result in reduced fishing mortality, unless there is so much excess fishing capacity that all the catch can be taken in the open season.

Unless certain conditions prevail, closing the fishery during the spawning season may not enhance reproductive output any more than closing it at some other time (i.e., simply reducing fishing mortality). A closed season

will most effectively enhance larval production if a significant proportion of the stock is too small to catch before the closed season, then matures and spawns during the closed season, before becoming available to the fishery in the following open season. Closing the fishery in the spawning season will also be effective if the organisms aggregate for spawning and are most easily captured at this time. Therefore, excluding the fishery from spawning areas will reduce overall fishing efficiency. Closure of a spawning area/season may be appropriate if fishing disrupts spawning.

Data and analysis requirements should include information on the seasonal and/or spatial distribution of reproductive activity. However, the declaration of closed areas (marine reserves) may be based on establishing a tourist attraction, with conservation of fishery resources being a spin-off.

Surveillance and enforcement requirements are less demanding for closed seasons than for closed areas. For the latter, areas must be clearly marked or identifiable by fishermen.

Royalty fees

These can be charged on either the volume or the value of the catch. They provide revenues from fishing which can, if set high enough, dampen fishing effort by increasing costs. Export fees are a form of royalty fee, on high value resources.

Data and analysis requirements include knowledge of the economic performance of individual fishing units in order to set realistic and effective royalty fees.

Surveillance and enforcement are not difficult if there are regular and organized markets, since royalty fees are best collected at the market level. In fact, they are often set as market fees with fishermen being required to pay daily market dues for the use of market facilities. Royalty fees are costly and difficult to administer without a market structure. Export tax on high priced resources are the least difficult to collect. If, as is usually the case, export licences are required, the collection of royalty fees may require minimal extra effort.

Individual vessel or enterprise quotas

These divide the available yield amongst the number of vessels or fishing enterprises, for example fishing cooperatives or communities, and represent the introduction of property rights in fisheries. They would be expected to encourage economic efficiency since owners of these rights can determine the best and most efficient means of taking their quota, and could also sell these rights in the open market. Such quotas will be most effective in a situation of overcapacity and high competition in the fleet, but could be implemented during the development phase of the fishery.

Fishery management strategy

It is not possible to discuss all feasible combinations of management tools (i.e., all possible management strategies) in detail. The OECS regulations for lobster are an example of a strategy where the objective is to reduce the catch of immature and actively reproducing individuals. The following tools have been employed: a minimum size limit which relates to size at maturity, prohibition of taking berried females, and fishery closure

during the reproductive season. Another example strategy for trap fisheries might be to regulate mesh size, in the knowledge that high fishing mortality will continue, and to close certain reserve areas to fishing in order to minimize the risk of recruitment overfishing.

Action: short term, long term, and the role of "commonsense"

The management strategy should be considered in terms of short, medium and long term action. There is a tendency for managers to delay action until "better information" is available. In fact in most instances, there are immediate "commonsense" actions which can be implemented on the basis of existing information. In many instances, immediate conservation oriented action may be called for. In the case of a resource which is clearly over-exploited and valuable, such as conch, steps to reduce fishing effort could be taken without a detailed assessment. For example, active fishermen could be licensed, and no new licences issued until monitoring indicated that the resources had recovered to acceptable levels.

Given the uncertainty and variability associated with resource assessment, even long term management of certain resources may be most effectively achieved by the application of 'commonsense' measures and monitoring. This will be particularly so for small-scale multispecies fisheries which, although important as sources of food and employment, may not generate much revenue. Such resource assessment activities as could be afforded would still play a valuable role in developing 'commonsense' measures. This idea is consistent with the principle that the best available scientific information should be utilized in determining the appropriate management strategy.

PART 3: RESOURCE SPECIFIC MANAGEMENT OPTIONS

INTRODUCTION

The fisheries of greatest importance to Eastern Caribbean countries are for lobster, conch, reef fishes, deep slope and bank fishes, and offshore pelagics. Coastal pelagics, sea turtles, sea urchins, whales and porpoises and seaweeds are of less importance. There are probably few currently unexploited resources in the region. However, some, such as squids, may have the potential to support fisheries, and plans should be prepared for these as exploitation intensifies.

In this part of the Management Options document, management options are presented separately for each resource type. The offshore pelagics are treated in three groups. The first is large pelagics for which stocks are likely to be contained within the Lesser Antilles region, the second is large pelagics with stocks which are distributed oceanwide, or at least known to be widely distributed outside the Lesser Antilles region, and the third is flyingfish.

All the Management Options Sections for the individual resources are organized in a similar fashion:

Management Plan

- Introduction
- Management objectives
- Problems for resolution
- Management unit
- Current regulations
- Management options and implications
- Habitat conservation
- Regional implications
- Action summary

Supporting material

This consists of basic biological, assessment and fishery information on which evaluation of the management options depends.

INSTITUTIONAL CONSIDERATIONS

Island/country level

In OECS Member States and Barbados, Fisheries Divisions are responsible for all aspects of fishery research, development and management at the local level. The responsibility for these activities is usually vested in a very few individuals. Given the priorities of day to day running of the fisheries, basic information gathering, extension education, etc., there is very little time and manpower available for data collection and applied research.

Considering the variety of activities to be carried out by the Fishery Divisions, prioritization of these activities, and rigorous adherence to those which can be accommodated with the manpower available will be crucial to effective management. Some degree of planning regarding structure and function of a small Fishery Division is evident in several islands. However,

it would be useful to generalize the process of planning a Fishery Division for a small island. Such an undertaking is beyond the scope of this document.

Regional level

The management of shared resources will be an important consideration for the Lesser Antilles region. Among OECS States, the OECS Secretariat and its Fisheries Unit provide appropriate mechanisms for cooperative management of shared resources. Under CARICOM, the mechanisms could be expanded to include Barbados and Trinidad and Tobago, in the eastern Caribbean. Mechanisms for joint management by the above countries, the EEC islands (France, UK, Netherlands) and the US territories are lacking. The Western Central Atlantic Fisheries Commission (WECAFC) of FAO, particularly the Lesser Antilles Committee, could provide a forum for discussion, but management agreements would require direct negotiation.

The Lesser Antilles also lacks an institution with the mandate to conduct applied fisheries research at a regional level, and to provide fishery management advice to Governments, as would be required to fulfill the responsibilities implied under UNCLOS (see Part 1). Fishery Divisions have minimal research capability, although they are often involved in collaborative research which could be of regional significance, for example, the Sea Grant Program activities in Saint Christopher and Nevis. The OECS Fishery Unit meetings, CARICOM Technical Meetings on Fisheries, and the FAO WECAFC Working Parties and Lesser Antilles Committee meetings are the main occasions on which such work can be discussed, and there is seldom time for detailed technical review. The Gulf and Caribbean Fisheries Institute, has been another forum for discussion of fishery management issues and for the presentation and review of relevant research. Altogether, the contribution of these mechanisms has been significant, but largely uncoordinated and with minimal access to the decision makers.

Several institutions have provided technical input to fishery management in the region: Biology Department, UWI, Barbados; Bellairs Research Institute of McGill University, Barbados; IFREMER, Martinique; West Indies Laboratory, Fairleigh Dickinson University, USVI; Island Resources Foundation, USVI; and the Department of Marine Sciences, University of Puerto Rico. None have the official mandate to carry out applied research and to provide management advice to governments in the region. Whether these institutions address matters which government Fishery Divisions consider to be important is a matter of chance, or choice on the part of the institution. Since Governments are not the main sources of research funding for most of these institutions, they have little say in the research conducted.

SUMMARIES OF RESOURCE SPECIFIC MANAGEMENT OPTIONS

Summary for lobster

Lobster is a high priced resource distributed on the island shelves. Most are either exported or sold to hotels and restaurants for tourist consumption. Rough estimates of potential yield from the Lesser Antilles indicate a total export value of US\$ 3.8 million, and a restaurant retail value of about US\$ 14 million. Lobster are considered to be fully or overexploited throughout the region with areas of severe local depletion. Although growth overfishing is almost certainly the case in most areas, there are no data from which to evaluate the possible effects of exploitation on recruitment. Young lobster inhabit inshore habitats which are subject to

destruction and degradation. Therefore, if diminished recruitment is documented, it will be difficult to distinguish between the effects of stock depletion and juvenile habitat loss or degradation.

Lobster should be managed primarily at the island shelf level, but shelves may be interdependent for recruitment due to planktonic dispersal of larvae and juveniles. Therefore, recruitment overfishing in one area could affect adjacent shelves. It is clear that in order to realize the full potential of the lobster resource, rehabilitation of overexploited areas, and subsequent careful management will be required.

Possible short-term action (1-3 years) includes: enforcement of current regulations, establishment of data collection systems for monitoring catch, effort and size composition of the catch in order to evaluate the response of the resource to the above enforcement; mitigation of habitat destruction and degradation.

Mid- to long-term action (3-10 years) could include refinement of estimates of optimal minimum sizes, and of potential yield of the resource for individual island shelves; evaluation of the possible role of artificial juvenile habitat in enhancing recruitment; and evaluation of the feasibility (social, geographical, and political) for community based management in the Lesser Antilles.

Summary for conch

Conch are fished on island shelves. Owing to their high value, most are either exported or sold to hotels and restaurants for tourist consumption. Rough estimates of potential yield from the Lesser Antilles indicate a total export value of US\$ 5 million, and a restaurant retail value of about US\$ 40 million. This resource is considered to be fully or overexploited throughout the region with areas of severe local depletion. Growth overfishing has probably occurred in most areas. There is no data from which to evaluate the possible effects of exploitation on recruitment. Young conch inhabit inshore habitats which are subject to destruction and degradation. Therefore, if diminished recruitment is documented, it will be difficult to distinguish between the effects of stock depletion and juvenile habitat degradation.

The most appropriate management unit for conch is probably the islands shelf, but since there may be interdependence among shelves for recruitment, overfishing on one shelf may affect neighbouring shelves. In order to realize the potential of the conch resource in the Lesser Antilles, stock rehabilitation followed by careful husbandry will be required.

Possible short-term action (1-3 years) includes: enforcement of current regulations, establishment of data collection systems for monitoring catch, effort and size composition of the catch in order to evaluate the response of the resource to the above enforcement; mitigation of habitat destruction and degradation.

Mid- to long-term action (3-10 years) could include refinement of estimates of optimal minimum sizes, and of potential yield of the resource for individual island shelves; and evaluation of the feasibility (social, geographical, and political) for community based management in the Lesser Antilles.

Summary for shallow shelf fishes

Trap and handline fisheries for reef fish are among the most socio-economically important in the Lesser Antilles, although they are small-scale and the fishermen are typically low-income and often part-time. Reef fish resources are considered to be overexploited throughout the region, with the possible exception of a few islands with large shelves. The evidence is low catch per trap, small size of fish, and the scarcity of the larger, more valuable species. In northern islands, ciguatera continues to be an impediment to full utilization of these resources. Rehabilitated and properly managed, this resource is the one most likely to provide a continuous, stable yield which is easily accessible with minimum investment in fishing gear.

Reef fish fisheries should be managed primarily at the island shelf level. Where two or more States share a single shelf, joint management is indicated. However, management should consider possible recruitment interdependence of shelves due to dispersal of eggs and larvae in currents. Under these conditions, overfishing in one area may reduce the supply of recruits to a neighbouring area.

Management should be aimed at rebuilding reef fish populations. It could be oriented toward maintaining these fisheries as small-scale, or toward greater capital investment in more efficient technology. Assuming the former strategy is chosen, management measures should be simple and easily enforceable, with the immediate objective of reducing fishing mortality, especially on juvenile fishes.

Short-term action (1-3 years) could include: monitoring systems for catch, effort, species composition, and size composition; prosecution of dynamiters; and regulation of trap mesh at the current size, or 1.5 inches, whichever is greater.

Medium to long-term action could include: licensing of fishermen where overexploitation is evident, and the reduction of effort through attrition. This should have minimal negative impact on fishermen, should result in increased total catches from the shelf areas, and should gradually improve the standard of living of these small-scale fishermen. Research should be aimed at island specific estimates of the status of the resource (via a regional program), and estimates of potential yield; evaluation of the feasibility and value of reserves and parks as reservoirs of mature fish; and most importantly, exploration of possibilities vesting the responsibility for management in the users, at the community or cooperative level.

Summary for deep slope and bank fishes

Deep slope and bank fishes are harvested with traps and handlines. These fisheries can be mechanized using electric reels and trap winches. Although there are reports of local depletion in the Lesser Antilles, particularly of known spawning aggregations, there is no reliable information on the state of exploitation of these resources. There is probably scope for expansion of these fisheries, and thus a need for policy decisions regarding the mix of commercial versus small-scale effort which would be desirable.

Because there is not much deep slope and bank habitat in the region, the total abundance of these resources will be relatively small and assessment of potential yield would be desirable before development proceeds much farther. Only very rough estimates are available at present. These suggest a total annual potential yield for the Lesser Antilles in the order of 700-800 t. This could

be taken with a fleet of about 20 mechanized mid-size (15 m) 'snapper' boats, and there are already several new vessels of this size range in the region targeting this resource with traps and lines. Therefore, full, or overexploitation is likely within three to five years.

Various measures may be useful in conserving the resource, but in the long term direct limitation of fishing effort will probably be required if overexploitation is to be prevented. The action required to move towards effective management of this resource is summarized below.

Short-term action (1-3 years) includes: establishment of systems for monitoring catch, effort, and size and species composition; policy decisions regarding development of fishing effort; and refinement of rough estimates of potential yield using data from similar areas elsewhere in the world.

Mid- to long-term action (3-10 years) could be oriented toward refining of estimates of potential yield and determining the effects of exploitation on reproductive potential.

Summary for large pelagics with stocks extending outside the Lesser Antilles region

Offshore pelagic resources are considered to hold the greatest potential for fishery development in the Lesser Antilles, and most islands intend to increase their effort in these fisheries. Several species (tunas, billfishes, dolphin, wahoo, kingfish, sharks) are exploited on the same fishing trips, often together with flyingfish, by boats ranging from canoes to launches. In this plan, species with stocks extending outside the Lesser Antilles region are considered (large tunas, billfish, swordfish), are considered.

Although these species are assessed by ICCAT, the status of the stocks, is poorly known in the Western Atlantic where the data base is weak. Without substantial investment in purse seine or longline vessels, the proportion of these species caught by Eastern Caribbean countries will probably remain relatively small. Considering that Lesser Antillean islands have little control over the fisheries for, and thus the conservation of, these stocks, there is little point in undertaking extensive stock assessment independently of ICCAT activities. However, there are several courses of action which will contribute to the regional capacity to utilize those resources to which it has access, and to contribute to their management.

Short-term action should include: a development policy for offshore pelagics; monitoring systems for catch and effort data by species, as well as for length frequency samples; representative(s)/observer(s) from the region to participate in ICCAT activities and liaise with other regional management groups such as the Caribbean Fishery Management Council; continuation of the current emphasis on reducing unpermitted fishing through regional cooperation in surveillance and enforcement; review and revision of preliminary estimates of potential yield.

In the medium to long-term, catch rates within the region should be used in the context of ICCAT assessments to evaluate the scope for further expansion.

Summary for large pelagics with stocks contained
within the Lesser Antilles region

Offshore pelagic resources are considered to hold the greatest potential for fishery development in the Lesser Antilles. Most islands intend to increase their effort in these fisheries in which several species (tunas, billfishes, dolphin, wahoo, kingfish, sharks) are exploited on the same fishing trips, often together with flyingfish, by boats ranging from canoes to launches. In this plan, species with stocks which are probably contained within the Lesser Antilles region (dolphin, kingfish, small tunas), are considered.

Although most of these species, dolphin being the main exception, come under the auspices of ICCAT, they have received virtually no attention owing to the emphasis on large tunas, billfish, and swordfish, and also to the absence of data. If the stocks of these large pelagic species which are exploited by Lesser Antillean islands are contained within the region, these fisheries, and the management measures implemented here could have a significant impact on their status and sustained optimum utilization.

Proper management of these species, many of which will probably be migratory will require a regional effort, both in research and in implementation of management measures.

Short-term action (1-3 years) should include: a development policy for offshore pelagics (commercial, small-scale, recreational, or combination); monitoring systems for catch, effort and length data; review and revision of current crude estimates of potential yield provided by Marcille, using all available data from tropical pelagic fisheries. This would allow planners to make a preliminary estimate of the scope for expansion, as the difference between the current catch and the most reasonable estimate of potential yield for the region.

Medium-term action (3-5 years) should be oriented toward setting up preliminary allocations of the estimated yield among islands according to agreed principles (this can be as simple, or as complex as desired), thus giving islands some indication of the potential for fleet expansion. First estimates of vessel equivalency should be agreed upon among islands. In the long term (5-10 years), catch data should be analysed for migratory patterns and effects of increased exploitation, leading to revised estimates of potential yield and vessel equivalency.

Summary for flyingfish

In the southern Lesser Antilles (except Saint Vincent and the Grenadines) flyingfish is an important component of the catch. Northern islands (Saint Christopher and Nevis, Antigua) are exploring the possibility of starting fisheries for flyingfish. These Eastern Caribbean countries probably share a common stock. Therefore, the fate of the resource and hence the fishery could depend largely on management measures implemented in the Eastern Caribbean. The current degree of exploitation (i.e., catch in relation to potential yield) is unknown. However, given the recent rapid expansion of the flyingfish fleet in Barbados, a period of slow expansion and monitoring may be warranted to allow the effects of this increased fishing effort to be assessed.

Assuming that overcapacity will develop in this fleet as it has in other fisheries, it will ultimately be necessary to limit catch, probably indirectly through limiting fleet size, or fishing seasons. Total Allowable Catch (TAC) management is potentially most precise, but will probably be impractical to monitor. Fleet size control would be coarser, but easier to manage. The fact that the resource is shared among islands must be considered. Limiting the size of the regional fleet will require agreement on equivalency of vessels (i.e., how many pirogues equal one 'ice boat'?). Provision will be needed for the fact that boats fish many species and the appropriate size flyingfish fleet may not be big enough to catch an appropriate share of other species.

A regional flyingfish assessment program, the Eastern Caribbean Flyingfish Project (UWI, McGill, IDRC) is attempting to determine whether there are significant quantities of flyingfish outside of the area in which the fishery now concentrates, and to determine appropriate exploitation rates for the stock. Preliminary analyses suggest that, owing to a considerable inter-annual variability in the abundance of flyingfish, traditional deterministic stock assessment methods will not be applicable. Instead, an approach which attempts to evaluate the risks of and returns from various fishing options will be considered.

Summary for coastal pelagics

Fisheries for coastal pelagics vary considerably in importance among islands, ranging from about 30% of the catch in Grenada to less than 1% in Barbados. Although several islands report declining catches of coastal pelagics, neither the extent of the decline, nor the species involved are documented. There is very little information on the distribution or migration of these species.

These fisheries should be managed at the island shelf level, although further research will probably reveal that stocks are more widely shared. Fisheries for coastal pelagics probably have little potential for expansion. However, if they are currently overexploited, proper management could result in higher yields. Unfortunately, there are no data on which to base a management strategy. The nature of the fishery is such that it may be self-regulatory, or that community-based management could be successfully implemented in many places. It appears unlikely that the value of the resource will warrant extensive application of traditional resource assessment techniques.

Short-term action (1-3 years) should include: establishment of data collection systems for catch, effort, and species composition in these fisheries; sampling for sizes where possible; investigation of fishing practices and community attitudes to community based management. Medium to long-term action (3-10 years) would be based largely on the findings of the short term investigations.

Summary for sea turtles

Four species of marine turtle which are commonly encountered in the eastern Caribbean. All are long lived and late maturing, and must return to the beach to lay their eggs. Adults are captured at sea and on the beach while nesting, whereas eggs are harvested from nests. These characteristics make sea turtle populations particularly susceptible to overexploitation. While immature, and between egg laying episodes, sea turtles remain at sea, often migrating long distances. All species are already severely over-exploited, or impacted by nesting beach degradation, throughout the western central Atlantic.

Owing to their migratory habits, the wider Caribbean should be the minimum management unit for these marine turtles. Short-term measures should include a moratorium on exploitation, already approved by OECS countries, and about to be adopted by other Eastern Caribbean countries. Measures against loss or degradation of nesting beaches should be given priority, and will be consistent with good coastal zone management practices for tourism development. Local measures which can assist in rebuilding turtle populations, include returning disoriented hatchlings to the sea, rearing hatchlings, nest relocation, light control on nesting beaches. The public should be educated toward engaging in these activities, and special interest groups should be encouraged to monitor nesting frequency in order to detect the response of the populations to these measures.

If and when the turtle populations rebuild to levels which can safely sustain exploitation, it will be necessary to devise a management strategy.

Summary for sharks and rays

Sharks and rays are a component of the fisheries treated under four other plans: shallow shelf, reef fishes; deep slope and bank fishes; and large pelagics both oceanwide and contained within the Lesser Antilles. They are treated separately here because of certain distinctive characteristics, and because of a recent emphasis on improved fishing methods for sharks in Trinidad and Tobago, and Dominica.

Sharks differ from other fishes in that they are generally large, long-lived and have low fecundity. This combination of characteristics makes them susceptible to overexploitation at relatively low fishing mortalities. The biology of sharks is relatively poorly known. The fact that shark is not a preferred fish among consumers in the eastern Caribbean region, has deterred investment in fisheries specifically for sharks. However, with special programs to educate consumers in ways of preparing this low priced commodity, increase targeting for shark may be expected.

If specific fisheries for shark develop it will be necessary to monitor them closely in order to prevent overexploitation. In the meantime, data for shark catches should be recorded separately by species wherever possible.

Summary for sea urchins

Sea urchins support small-scale fisheries in several islands in the southern Lesser Antilles. The gonads are a consumer delicacy in some islands, notably Barbados and Martinique, and also fetch high prices as suishi in metropolitan centres and especially in Japan. Extraregional export markets have not been explored. It is likely that all the production from the Lesser Antilles could be consumed within the region, but export markets could be more lucrative.

Several islands with sea urchin resources do not presently have fisheries. This is probably because they are not a traditional food, and export markets have not been developed. As sea urchin fisheries develop in islands other than Barbados, the pattern of overexploitation observed in Barbados is almost certain to be repeated. If export markets for the fresh product are found, the result could be a substantial increase in fishing pressure on the resource. It would be dangerous to develop fisheries for export markets without mechanisms for controlling exploitation. Given the relatively small total size of the resource, extensive management will probably not be economically justifiable and community based approaches should be explored.

Short-term action should include: developing fisheries and markets, both local and export in islands where none exist; and exploring the feasibility of community or group based fishing rights to specific areas.

Medium to long-term action should be oriented towards deriving rough estimates of potential yield per unit area for sea urchins and to map suitable habitats in islands where there are fisheries, or where there are plans to develop fisheries.

MANAGEMENT OPTIONS FOR SPINY LOBSTER

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MANAGEMENT PLAN FOR SPINY LOBSTER

Introduction

Lobsters are fished on the island shelves primarily by traps and divers using snares (loops). They have a high market value and most of the catch is exported or sold to hotels and restaurants. Owing to its accessibility and value this resource is overexploited in most islands, especially in islands with small shelf areas. In every island there is local depletion in easily accessible areas and depths. The abundance of these animals in less accessible areas is unknown.

Lobsters have a long planktonic larval stage during which they may be dispersed between islands. As juveniles and adults they are sedentary. Adults mature after several years and are marketable prior to sexual maturity.

Owing to the high mortality associated with a long larval life and the likelihood of capture of immature lobsters, this resource may be susceptible to recruitment overfishing. There are presently no data to indicate whether continuing low levels of abundance in depleted areas are due to low recruitment or persistent high levels of exploitation of those individuals which do recruit. Since larvae may disperse between islands, recruitment collapse may be felt throughout the region.

At the regional level, lobster is probably the most valuable single resource. In the past, it has been a significant earner of foreign currency, although as tourism develops, most islands will probably utilize their lobster production locally.

Management objectives

The objective should be to maximize foreign exchange, either through exports or supplying the tourist industry. To achieve this, overexploitation must be prevented where it has not yet occurred, and rehabilitation of over-exploited stocks must be promoted.

Problems for resolution

Lobsters are probably either overexploited or fully exploited. Consequently, management should aim at reducing fishing effort, directly or indirectly. Although there are few analyses, growth overfishing is almost certain in heavily fished areas. The extent to which recruitment overfishing has occurred is unknown, but could become more evident as depletion expands to distant parts of larger island shelves, and into deeper water.

There is a lack of reliable data, or data collection mechanisms with which to: assess the current status of the resource; evaluate the impacts of management measures; and estimate the current or projected value of the resource.

There continue to be fishing practices which can result in considerable non-landed fishing mortality: spears, hooks, scrubbing of eggs, and the use of undersize lobster as attractants in traps.

Critical habitats for juvenile lobsters are steadily being destroyed or degraded by the impacts of tourist, urban, and industrial development on the coastal zone.

Management unit

Management units for lobster should be considered at two levels. The first level relates to the distribution of the demersal juveniles and adults, and is therefore the island shelf. For most management measures, this will be the appropriate unit. Where two or more States share the same shelf, joint management is indicated. The second level relates to the likely interaction of demersal stocks through planktonic early life history stages. Therefore, owing to possible effects of overfishing in one area on recruitment to a neighboring area, local regulations may have regional implications.

Current regulations

In the OECS Member States and Barbados, lobster are, or soon will, be protected by minimum-size limits, restrictions on taking berried females or molting individuals and on method of capture. In addition, a closed season may be effected on notice. In many Caribbean countries, such regulations have been in place for several years, but are seldom enforced.

Management options and implications

1. No action

Although there are management regulations, there is virtually no enforcement in most places, so that the "no action" option is essentially in effect. The likely consequences of continuing in this mode have been made clear by the historical pattern of decreasing size and abundance. The likelihood of recovery in depleted areas will be minimal, and exploitation can be expected to expand to, and deplete, less accessible areas. Although there

is currently no evidence of recruitment overfishing, continued expansion of fishing, and the accompanying stock depletion will eventually lead to significantly diminished recruitment.

2. Size limits

Minimum-size limits are currently based on the size at first maturity in an attempt to guard against recruitment overfishing. Information on size at first maturity which is more specific to the eastern Caribbean should be acquired. Yield-per-recruit analysis may be appropriate to obtain information relevant to growth overfishing. The minimum-size limit should be modified if justified by the analysis. There is currently some controversy as to the survival of under size lobsters or "shorts" discarded at sea. In Florida, these may be used as attractants in traps, but cannot be landed.

Since size limits allow for the harvesting of all individuals above the limit, this approach may be too lenient. In the USVI and Puerto Rico, the Caribbean Fishery Management Council has noted that the average size of legal lobsters (above minimum-size) is extremely close to the minimum size. This suggests that the fishery harvests most of the legal-size lobsters.

Since most lobsters are exported or sold to hotels and restaurants, size limits can be enforced by checks at these institutions as well as at landing sites.

3. Closed seasons

A closed season for lobster may serve to reduce overall fishing mortality, but may not significantly enhance larval production. In theory closing the fishery in the spawning season offers no more protection than closing it at any other time. In practice, fishermen identify with the conservation of actively reproducing organisms, and are supportive of closures, thus affording the stock some measure of protection.

A closed season is one of the least difficult regulations to enforce. The problem of imported lobster making enforcement difficult can be minimized by harmonization of closed seasons.

4. Limited entry

Limited entry may be an appropriate management tool for the component of the fishery which targets lobster, namely SCUBA and lobster traps. However, a considerable amount of lobster is taken in traps set for lobster and fish. Establishing appropriate effort levels at which to limit entry will be much more difficult in these mixed fisheries.

Limited entry would have to be based on estimates of lobster yield for each island shelf, or on a program of gradual attrition of fishing effort (assuming overexploitation is the rule) and monitoring of catches to identify appropriate effort levels. Although rough estimates of lobster yield per unit area of shelf are available, they are not accurate enough to be used in setting effort limits.

5. Total allowable catch (TAC)

If limited entry is not acceptable, and there are clear indicators of overexploitation, and the current catch is known, a TAC equal to or less than the current catch could be set to prevent further depletion of the stocks. As

for limited entry, TAC regulation should be based on an estimate of potential yield, and problems noted under that heading must be borne in mind.

TAC regulation will require monitoring of landings as they occur, and the political will to close the fishery when the TAC has been taken. TAC enforcement may be feasible in places where most of the catch is either exported or sold to hotels and restaurants, depending on the extent to which middlemen are involved, or to which there is cooperation from hotels and restaurants. Exceptions are those islands where export by air may be difficult to control (e.g., Anegada, Barbuda), where the catch may be landed on other islands, or where it may be transshipped at sea (e.g., Anguilla to Saint Maarten, Tortola to USVI).

Given the ready market for lobster, TAC regulation could precipitate an annual race for the TAC, resulting in its being taken early in the management season. The outcome is difficult to predict. In the event of a race, any temporary surplus might be exported, and local restaurants could be left without access to lobster for a considerable part of the season. Alternatively, they may take advantage of the surplus to stockpile at deflated prices. A race for the TAC can be avoided by allocating property rights so that fishing enterprises can take their allocation in an efficient and orderly fashion, over the entire season. Altogether, this route could be expected to lead to a complicated management regime with substantial administrative overheads.

6. Gear restrictions

The use of spears in harvesting lobster is destructive. Other gears such as loops, allow extremely intensive harvesting, especially in combination with SCUBA.

Banning the use of SCUBA gear in harvesting lobster will provide a deep water refuge, and reduces the efficiency of harvesting in shallower areas. Enforcement of a SCUBA ban will be difficult unless all fishing with SCUBA is banned or unless it is made illegal to have SCUBA gear and lobster in the same boat.

7. Communal property rights

Although there is minimal information on the fishing patterns of lobster fishermen in the Lesser Antilles, many travel relatively long distances to fish. Thus, fishermen from several communities may fish in the same area reducing the feasibility of community based resource management for lobster. However, there may be certain local situations which would facilitate this approach.

Where feasible, the community approach to management will be the least costly to administrate.

Habitat conservation

Critical coastal habitats for juveniles (e.g., mangroves, seagrass, coral rubble fields) should be protected from destruction and degradation.

Active involvement of fisheries personnel in coastal development planning should be promoted with the aim of representing fishing industry interests and resolving user conflicts in critical habitats.

Regional implications

Existing regulations are largely harmonized at the OECS/CARICOM levels. Efforts should be made to synchronize closed seasons (as have Saint Vincent and the Grenadines and Grenada), and further measures should also be harmonized. Widespread implementation of catch and effort monitoring throughout the region would provide the basis for estimation of potential yield by comparison of island shelves. Coordination of this exercise, and some additional information on relative fishing power of different vessels and gear would be required.

Stocks which are shared through the exchange of resident individuals (e.g., shared shelf situations) will require cooperative management. Any island attempting to manage only its part of a shared stock will have incomplete information. Assessments using incomplete data could be erroneous and could lead to inappropriate regulations. Inequality in the management of a shared stock could result in the less well managed area 'siphoning off' the resource from the more restricted area. Thus, management of these stocks requires cooperation in data collection, stock assessment, research and regulation.

Action summary

Short term (1-3 years)

Monitoring systems for catch, effort and length frequency data should be established immediately. Current regulations should be rigorously enforced, and the monitoring systems used to evaluate their impact. The Cuban experience with lobster indicates that these measures alone should provide significant increases in yield and size of lobster in the catch.

Destructive fishing practices and gears (e.g., spearfishing, SCUBA) should be banned.

There should be increased efforts to mitigate destruction and degradation of coastal habitats for juveniles.

Long-term action

Depending on the availability of funds, action oriented toward long-term improvement of lobster management could be initiated immediately, or could be delayed pending some results from the short-term action described above. It is possible that rigorous enforcement of existing regulations may produce adequate results. Therefore, further expenditure on lobster management may not be economically justifiable.

Activities oriented toward long-term management could include:

1. Evaluation of suitable locations for community based management.
2. More precise estimates of size limits required to minimize growth overfishing and to increase reproductive capacity.
3. A program to estimate potential yield from island shelves.
4. Evaluation of the feasibility of using artificial habitats for juveniles to boost productivity in adult habitats.
5. Evaluation of the feasibility of ranching.

SUPPORTING MATERIAL FOR SPINY LOBSTER

The information in this section has been summarized from Appeldoorn, Dennis and Monterossa López (1987), unless otherwise referenced.

Species composition

Panulirus argus is most abundant and commercially important of the three Caribbean species of this genus. The others are P. guttatus and P. laevis.

Stock structure

P. argus is distributed throughout the southwestern Atlantic off the coast of central Brazil; the Caribbean Sea, including the Lesser and Greater Antilles and the north and east coasts of South and Central America, respectively; the Bahama Islands; the Gulf of Mexico; southeast Florida northward to Cape Hatteras, N.C.; and Bermuda.

Many Lesser Antillean islands share a common island platform (e.g., US and British Virgin Islands; Anguilla and Saint Martin, Saint Barthelemy; Saint Eustatius and Saint Christopher and Nevis; Grenada and Saint Vincent and the Grenadines). Although lobsters are usually considered to be restricted to the shelf and slope habitats, the maximum depth for lobster distribution is unknown. Experimentally, lobsters at Bermuda have withstood depths of 457 m. Therefore, it is probable that at least those island groups within the 100 fathom line may be sharing common lobster stocks. One study suggests that juveniles and adolescents may disperse hundreds of kilometers from nursery to adult habitats. In the Lesser Antilles, a nursery area on one island could conceivably supply a large portion of juveniles populating other islands on the same island platform.

The long planktonic life of spiny lobster larvae makes it difficult to determine the origin of recruits to a local population. A surface drift model indicates that currents of the Caribbean could carry larvae great distances from their origin. They would then recruit to other populations "downstream", or perish. However, there are also significant small-scale currents, gyres and eddies which could retain larvae and return them to their parent population.

In Lesser Antillean islands, recruits probably originate from both "local" and "foreign" sources. Genetic studies indicate that recruitment to the populations studied (Key West, Florida; Cancun, Mexico; Jamaica; US Virgin Islands; Trinidad) may originate from less than several hundred miles. However, most Lesser Antillean islands are closer together than this, so significant interchange between them may well be the case. Therefore, even if adult stocks are isolated on island platforms, they may not be independent as regards recruitment, and are almost certainly genetically connected. In conclusion, the relative importance of local versus foreign recruitment remains unknown.

Fisheries

General status

Lobster remains the single most valuable fishery resource in the Lesser Antilles. Catch estimates from Lesser Antillean islands are poor or lacking. Therefore, it is not possible to properly estimate the current value of the fishery. However, the rough estimates of potential yield in Appendix 1 suggest that the annual yield from the island shelves and banks of the Lesser

Antilles (except USVI) should be about 1 000 t. Assuming an average price of US\$ 2.50/lb, the total value of this yield would be about US\$ 5.5 million. The portion of this yield from the island shelves of Barbados, Anguilla and the OECS Member States would be about 700 t/year with a value of about US\$ 3.8 million/year. The retail value of this catch in restaurants at about US\$ 10.00 per 500 g plate would be about US\$ 14 million, most of which would be foreign currency.

High demand for the Caribbean spiny lobster has resulted in widespread overfishing. New markets have developed both in the USA and Caribbean. With the rapid development of tourism in many islands, there has been an increase in demand such that these islands have gone from exporters, to importers of spiny lobsters. US imports from the Leeward Islands increased from 40 t (live weight) in 1960 to 548 t in 1978 then dropped to 27 t in 1980.

Owing to the value of the resource, lobster fishermen, and fishermen in general in islands with appreciable lobster resources, are well off relative to fishermen who target shelf fishes, or pelagics from small craft. However, the economic data to substantiate this are not available in most islands.

Current management

Until recently, lobster management in the Lesser Antilles consisted of a variety of size limits, closed seasons, bans on harvesting molting or berried lobsters, and restrictions on the use of impaling gear (DuBois, 1985). In 1984, the OECS initiated the process of harmonizing regulations for lobster fishing. These regulations included the above measures, with one size limit for all islands. The implementation of these regulations is at various stages in various islands.

There has been little or no enforcement of the past or harmonized regulations in any island. Therefore, there is no way of evaluating the extent to which these regulations may reduce overexploitation and promote rehabilitation of the resource.

Population biology

Growth and mortality

Lobsters grow by molting. The length of the intermolt period increases as size/age increases, averaging 60 to 90 days for mature P. argus. Mature males grow approximately 3 cm per year, while females grow only 1.5 cm per year due to egg production and care.

Males and females attain 95% of their maximum size in seven and ten years, respectively, in the US Virgin Islands. Legal size (approximately 700 g) is reached by males in approximately two years of benthic life and by females in four years. Growth rate variation within the same locality has been documented in several places.

Length-frequency data from populations of P. argus in Jamaica, indicated an annual instantaneous natural mortality rate (M) of 0.14 to 0.52 and a total (fishing and natural) mortality rate (Z) between 0.50 to 1.52, depending on the degree of exploitation. For example, total mortality has been reported as 56-78% in Cuba, and 33-48% in the US Virgin Islands where strict catch limits are enforced. In Cuba, M was estimated to be 0.56.

Reproduction

The smallest sizes at sexual maturity (as indicated by the presence of eggs on females) were reported as 45 mm, 57 mm, and 65 mm carapace length (CL) by different researchers. However, most investigators cite 80-90 mm CL. Variations in the size at sexual maturity between localities are probably due to environmental conditions, but this has not been specifically examined.

Spiny lobsters move to the shelf edge to spawn. The number of berried females (females with eggs) usually increases with depth. P. argus spawning patterns vary throughout its range; from once a year (between March and July) in Florida and the Bahamas, to year-round with maxima in spring and fall in Venezuela. In the Caribbean, berried females occur in all months.

At Bimini, observations on egg carrying females from 74 to >120 mm CL showed that females larger than 81 mm CL had the highest population reproductive potential. For example, females in the 96-100 mm CL size range, representing 3.6% of the population, provided 13.9% of total egg production, whereas newly "mature" females, 70-75 mm CL, constituting 14.9% of the population, provided only an estimated 2.3% of total egg production (i.e., 25 times less productive). Evidence of the relative importance of larger females in contributing to population reproductive potential, and the relatively poor contribution of smaller, newly mature females has also been found in Florida, and in Saint Christopher (Goodwin, Heyliger and Wilkins, 1986).

Artificial habitats have been used to monitor puerulus recruitment for Panulirus species in western Australia, southern California, south Florida, and Puerto Rico. Reports from the Caribbean (Antigua and Barbuda, Puerto Rico) indicate year-round recruitment of P. argus with greatest influx in late summer-early fall and a smaller peak in spring. In addition, lunar periodicity of recruitment has been reported for P. argus in Florida, Cuba and Puerto Rico.

Assessment and management

In theory, lobster management could be based on any of the standard assessment techniques. Some of these could be applied in the near future, others would require considerable research. Which of these can and should be used depends on what can be enforced and the amount of money allocated for management.

Whereas it is evident that growth overfishing has taken place in most areas, there is no hard evidence that the recruitment potential of the resource has been affected by the depletion which has taken place. The lack of recovery in easily accessible depleted areas could be due to poor recruitment, or to sustained fishing pressure from traps set for fish, or from part-time/recreational divers. Nonetheless, most current regulations are oriented toward protecting reproductive potential.

Growth overfishing and yield/recruit (Y/R)

In the Caribbean, yield/recruit models have been applied only in south Jamaica, where Munro concluded that any increase in the length at first capture (up to 125 mm) would significantly improve the yield per recruit. Some of the input data for yield/recruit models are available from the eastern Caribbean. The required data include growth parameters, natural mortality and

recruitment pattern to the fishery. Further estimates of these parameters and Y/R analysis specific to the region, coupled with length frequency data from the catch, would indicate the extent of growth overfishing.

Recruitment overfishing

In spite of considerable research effort, relationships between spawning stock abundance and subsequent recruitment to the fishery have been difficult to demonstrate for Panulirus species (Pringle, 1986). The successful case of the Australian rock lobster, for which inexpensive yield prediction models have been developed, and appear to be useful, is based on over 35 years of focused research.

The observations on reproductive potential in the previous section have significant implications for the applicability of a closed season aimed primarily at enhancing recruitment by protecting spawning females. A closed season will most effectively enhance larval production if a significant proportion of the stock is too small to catch before the closed season, then matures and spawns during the closed season. For lobster, it appears that these individuals would be expected to contribute a relatively small proportion of total larval output. Measures aimed at conserving the number of large females in the population will be the most effective for enhancing larval output. In practice this can only be achieved by reducing total fishing mortality so that there is a higher probability that an individual female will reach a size where it can contribute an appreciable number of eggs, or by spawning stock reserves.

Potential yield

There are many ways of estimating potential yield. These range from extremely data intensive approaches, such as yield/recruit analysis coupled with prediction of recruitment from surveys or time series models, to extremely crude, such as using estimates from other parts of the world. One of the simpler approaches would be to obtain (good) estimates of current yields from island shelves in the Lesser Antilles and to modify them according to perceptions of whether the area was fully or overexploited. The quality of data which would be used in modifying the observed yields would vary from island to island, and could include fishermen's perceptions of the status of the resource.

Some very rough estimates of potential yield from island shelves in the Lesser Antilles are based on a figure of 0.05 t per square kilometer of shelf area within the 200 m depth contour (Appendix 1). This figure includes a number of assumptions, for example that 40% of the shelf is suitable lobster habitat. Clearly this will vary considerably from one island to another, as will other factors influencing yield. Therefore, although the estimates may be useful as a guide to the likely value of the resource to the region, they are too rough to be used for island specific management.

The possibility of applying general production models, which consider the combined effects of all population parameters, growth, mortality and recruitment, to estimate potential yields from island platforms could be considered. The section on reef fish management by Mahon (1988) considers in detail the possibilities and problems of this approach. Similar arguments apply for lobster, except that there are far fewer species. As suggested for reef fish, a regional approach to estimating potential yield may be useful in providing approximate estimates for individual island shelves, and may be cost effective, particularly if carried out jointly with the reef fish program.

Habitats

Spiny lobster larvae, juveniles, and adults are ecologically dissimilar and require discrete habitats. Larvae are planktonic for about 6 months. Juveniles inhabit shallow coastal habitats such as seagrass, mangrove, and coral rubble in protected bays. As they grow older and larger they move gradually into deeper water, and offshore reef habitats.

It is accepted that degradation or loss of coastal habitats can negatively impact recruitment of lobsters to the fishery. Lobster management therefore requires that these 'critical' habitats be protected. These habitats are usually threatened by tourist and urban coastal development. Resolution of these conflicts among different economic sectors, is beyond a fishery management plan and should be pursued in the context of a coastal development plan.

MANAGEMENT OPTIONS FOR CONCH

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MANAGEMENT PLAN FOR CONCH

Introduction

Conch is probably the second most valuable fishery resource in the eastern Caribbean. Being relatively sedentary and aggregated in certain habitats, they are easily exploited by divers. Consequently, the queen conch is severely depleted throughout the Caribbean, and was one of the first species to be considered as overexploited. Various restrictions for conch have been in place in many Caribbean countries for several years. Recently, OECS harmonized fishery legislation has resulted in more specific regulations on shell length, maturity and meat weight.

Management objectives

The objective should be maximize yield for export and for local consumption either by residents or tourists. This should be pursued by preventing overexploitation where this has not yet occurred and by promoting rehabilitation of overexploited stocks.

Problems for resolution

Conch are probably either overexploited or fully exploited. Consequently, management should aim at reducing fishing effort, directly or indirectly. Although there are few analyses, growth overfishing is almost certain in heavily fished areas. The extent to which recruitment overfishing has occurred is unknown, but could become more evident as depletion expands into more distant parts of larger island shelves, and into deeper water.

There is a lack of reliable data or data collection mechanisms with which to: assess the current status of the resource; evaluate the impacts of management measures; and estimate the current or projected value of the resource.

Critical habitats for juvenile conchs are steadily being destroyed or degraded by the impacts of tourist, urban, and industrial development in the coastal zone.

Management unit

Management units for conch should be considered at two levels. The first level relates to the distribution of the demersal juveniles and adults, and is therefore, the island shelf. For most management measures, the island shelf will be the appropriate unit. Where two or more States share the same shelf, joint management is indicated. The second level relates to the likely interaction of demersal stocks through planktonic early life history stages. Therefore, owing to possible effects of overfishing in one area on recruitment to a neighbouring area, local regulations may have regional implications.

Current regulations

Various restrictions for conch have been in place in many Caribbean countries for several years. More recently, OECS harmonized fishery legislation has resulted in more specific regulations. Conchs must exceed 18 cm shell length and have a flared lip. In the case of conch landed without the shell, there is a minimum meat weight (without digestive gland) of 225 g.

Management options and implications

1. No action

Although there are management regulations, there is virtually no enforcement in most places, so that the "no action" option is essentially in effect. The likely consequences of continuing in this mode have been made clear by the historical pattern of stock depletion. Recovery in depleted areas will be unlikely, and exploitation can be expected to expand to less accessible areas which will in turn become depleted. Although there is currently no evidence of recruitment overfishing, continued expansion of fishing will probably lead to significantly diminished recruitment.

2. Size/age limits

The current minimum size limits and flared lip regulation are based on the preventing the harvest of immature individuals. This is aimed at preventing recruitment overfishing. Further information on size and other characteristics at first maturity which is more specific to the eastern Caribbean should be acquired. It may also be appropriate to conduct further yield/recruit analyses to obtain information relevant to growth overfishing and to modify the minimum limits if justified by the analysis.

Since size/age limits allow for the harvesting of all individuals above the limit, it is possible that this approach may be too lenient.

There are various enforcement problems with size/age limits. These are considered more fully under regional implications. In general, most conch are exported or sold to hotels and restaurants. Therefore, size limits can be enforced by checks at these institutions as well as at landing sites.

3. Gear restrictions

Banning the use of SCUBA gear in harvesting conch provides a deep water refuge, and reduces the efficiency of harvesting in shallower areas. Enforcement of a SCUBA ban will be difficult unless all fishing with SCUBA is banned or unless it is made illegal to have SCUBA gear and conch meat in the same boat. Note that banning SCUBA could result in complete closure of conch fisheries in many areas, at least until shallow habitat stocks are rebuilt.

4. Closed seasons

A closed season for conch during the reproductive period may serve to reduce overall fishing mortality, but may not enhance larval production to a significant degree. Unless the resource is more vulnerable at that time, or reproduction is disrupted by fishing, closing the fishery in the spawning season offers no more protection than closing it at any other time. However, in practice, fishermen identify with the conservation of actively reproducing organisms, and are supportive of closures, thus affording the stock some measure of protection.

A closed season is one of the least difficult regulations to enforce. The problem of imported conch making enforcement difficult can be minimized by harmonization of closed seasons.

5. Limited entry

Although conch are taken by only one fishing method, other species may be harvested on the same trips. The feasibility of a limited entry approach to regulating fishing effort on conch, will depend on the extent to which they are harvested along with other species, and will therefore vary among islands.

Limited entry would have to be based on estimates of conch yield for each island shelf, from which appropriate levels of fishing effort would be estimated. Since there are no such estimates which are sufficiently accurate for this approach to management, an alternative approach could be considered. Where overexploitation is obvious, units (boats or fishermen) currently fishing could be licensed and no new licences issued thereafter until attrition had reduced effort to acceptable levels. These levels could be identified either by monitoring catches, or by a program aimed at estimating potential yield from individual island shelves. Note that the rough estimates of conch yield per unit area of shelf presented in Appendix 1 are not accurate enough to be used in setting effort limits.

6. Total allowable catch (TAC)

As in the case of limited entry, TAC regulation should be based on some estimate of potential yield, and the problems discussed under that heading must be borne in mind. However, if limited entry is not acceptable, and there are clear indicators of overexploitation, and the current catch is known, a TAC equal to or less than the current catch could be set to prevent further depletion of the stocks.

Since most of the catch is either exported or sold to hotels and restaurants, TAC enforcement may be feasible in many places. Exceptions are those islands where export by air may be difficult to monitor (e.g., Anegada), where the catch may be landed on other islands, or where it may be transshipped at sea (e.g., Nevis to Montserrat).

TAC regulation will require that landings be monitored in real time, and the political will to close the fishery when the TAC has been taken. Considering the ready market for conch, TAC regulation could precipitate an annual race for the TAC, resulting in its being taken early in the management season. The outcome is difficult to predict. In the event of a race, any temporary surplus might be exported, and local restaurants could be left without access to conch for a considerable part of the season. Alternatively, they may take advantage of the surplus to stockpile at deflated prices. The "race" for the TAC can be avoided by allocating property rights so that fishing enterprises can take their allocation in an efficient and orderly fashion, over the entire season. Note that this is a limited entry situation with added measures to control the way in which the catch is taken. This approach leads to a complicated management regime with substantial administrative overheads.

7. Closed areas

Due to the discrete distribution of conch in preferred habitats, it may be feasible to manage by closing particular fishing grounds. This would be most useful as a remedial measure for rehabilitation of overexploited areas.

8. Communal property rights

There is minimal information on the fishing patterns of conch fishermen in the Lesser Antilles. However, owing to the relatively localized nature of the resource, and the tendency for conch fishing to be centered in a few communities in each island, there may be potential for community based resource management.

In principle, the community approach to management will be the least costly to administer. This approach assumes the existence of community organization which can set and monitor its own regulations. This may include deciding who may or may not fish. If there are several communities utilizing the same stock spread over several adjacent zones, coordination of practices will be required if less well managed areas are not to benefit at the expense of the better managed ones. Communities will require technical assistance in evaluating management options and in evaluating resource status.

Habitat conservation

Critical inshore habitats for juveniles (primarily seagrass) should be protected from destruction and degradation.

Active involvement of fisheries personnel in coastal development planning should be promoted with the aim of representing fishing industry interests and resolving user conflicts in critical habitats.

Regional implications

Existing regulations are largely harmonized at the OECS/CARICOM levels. Efforts should be made to synchronise closed seasons, and further measures should also be harmonized. Widespread implementation of catch and effort

monitoring throughout the region would provide the basis for estimation of potential yield by comparison of island shelves. Coordination of this exercise, and some additional information on relative fishing power of different vessels and gear would be required.

Situations in which one or more countries share a common island platform will require close cooperation in research and management. Any island attempting to manage only its part of a shared stock will not have all the information required. Assessments using incomplete data could be erroneous and lead to inappropriate regulations. A badly managed fishery could drain the resource from a better managed adjacent area.

As data allowing fine tuning of minimum-size limits become available, it will become less appropriate to apply a uniform size limit among islands. Conch growth may vary markedly, largely as a function of habitat. Furthermore, fisheries vary among islands. In some areas conch are landed with the shell, while in others the meat is removed at sea. Limits based on meat weight, applied when conch are landed without the shell, could suffer from the wide variability in the shell-size to meat-weight ratio, since meat weight cannot be assessed prior to killing the individual. A possible substitute might be to use operculum length.

Appeldoorn (in press) has suggested a 'relative size' limit based on characteristics relating to sexual maturity. Conch landed with the shell could be checked for a flared lip, or a lip of a certain thickness (e.g., 5 mm), whereas conch meats, if not skinned could be checked for the presence of a fully formed verge, or egg groove.

Action summary

Short term (1-3)

Catch, effort and size-frequency monitoring systems should be established immediately. Current regulations should be rigorously enforced, and the above monitoring systems used to evaluate their impact.

Efforts to mitigate destruction and degradation of coastal habitats for juveniles should be increased.

Medium to long term (3-10 years)

Action oriented toward long term improvement of conch management could be initiated immediately. However, rigorous enforcement of existing regulations may produce adequate results. Therefore, further expenditure on conch management may not be economically justifiable.

Activities oriented toward improvement of management in the long term, could include:

1. Evaluation of suitable locations for community based management.
2. More precise estimates of size limits required to minimize growth overfishing and to increase reproductive capacity
3. A program to estimate potential yield from island shelves.

SUPPORTING MATERIAL FOR CONCH

The information in this section has been summarized from Appeldoorn, Dennis and Monterossa López (1987), Appeldoorn (1987), and references therein, unless otherwise referenced.

Stock structure

Queen conchs (Strombus gigas) occur throughout the Caribbean, southern Mexico, Florida Keys, Turks and Caicos Islands, Bahamas and Bermuda. They are not found south of the Orinoco River.

Movements and migration have not been extensively studied. The most definitive work found that conch migrate seasonally: offshore in September-October; inshore in March. Conch are generally least active in winter. Adults can range several kilometers. Tagged individuals moved 2 km within a two-month period. Off Puerto Rico, isolated recaptures showed up to 9 km displacement over six months. In a deep-water population, conch migrated to deeper water (45 m) in October-November and to shallow water (20 m) in March.

The stock structure of queen conch is unknown. Circulation patterns within the Caribbean and the duration of larval life indicate that both downstream transport and/or retention of larvae are possible. Within the eastern Caribbean, it is likely that larvae from throughout the region combine to form a mixed pool of larvae, which could recruit over an equally broad region.

Electrophoretic analysis of gene frequencies from various populations found no fixed allele differences between areas. Populations in the eastern Caribbean showed differences from those in Belize and Turks and Caicos, indicating possible or partial isolation. However, gene frequency differences can arise due to selective mortality, as well as isolation. Furthermore, differences were found between populations from the north and south coasts of Saint Lucia, and more recently (Appeldoorn, in lit.) between sites in Belize. The interpretation of this is unclear.

Any islands sharing a shallow shelf (<60 m) of suitable conch habitat would obviously have a potential for directly sharing the same resource, as adults have the capacity to move from one area to the other. However, this has not yet been observed.

Fisheries

General status

Queen conch is probably the second most valuable single species resource in the wider Caribbean (see under potential yield below), but most of the production comes from areas with abundant shelf habitat, e.g., Belize, Bahamas, Turks and Caicos Islands. Relative to these areas conch were never abundant in the Lesser Antilles, although commercially valuable concentrations occurred on most islands. Martinique and Guadeloupe are the primary export market for eastern Caribbean conch. Conch stocks throughout the Caribbean region are considered to be fully or overexploited. However, there is a general lack of data, and of reliability in the data that do exist.

The very rough (order of magnitude) estimate of 1 200 t/year for the potential yield of conch from the entire Lesser Antilles, USVI excluded which has been attempted in Appendix 1, allows a preliminary estimate of the value of this resource to the region. Of the above amount, about 850 t/year would be from the OECS islands, Anguilla and Barbados. Assuming an export value of about US\$ 6.00/kg, this yield would be worth just over US\$ 5 million. Retailed to tourists in restaurants at about US\$ 10.00 per 200 g meal, this annual conch yield would be worth about US\$ 42 million in foreign currency earnings.

Conch are harvested primarily by free diving in shallow waters, and scuba diving in deeper water. In some areas divers routinely work at depths over 100 ft. Where fishing pressure is heavy, conch will recruit to the fishery at 150 mm in length (roughly 1.5-2 years of age). The catch is either sold to hotels and restaurants where most is consumed by tourists, or is exported.

Owing to the value of the resource, conch fishermen generally earn higher incomes than fishermen who target shelf fishes, or pelagics from small craft. However, the economic data to substantiate this are not available in most islands. In certain islands, for example the BVI, an appreciable proportion of conch may be harvested by recreational divers. In general, for those islands where conch is a significant part of the catch, fishing tends to be pursued from only a few landing areas.

Current management

Until recently, conch management in the Lesser Antilles consisted of a variety of regulations enacted or proposed to reduce fishing pressure. These include a minimum size limit on shell length, shell diameter, lip thickness, or meat weight, and seasonal closures.

In 1984, the OECS initiated the process of harmonizing regulations for conch fishing. These regulations are primarily a minimum size limit of 18 cm shell length and 225 g market weight, the presence of a thickened shell lip, and the prohibition of SCUBA fishing for conch on all islands. The process of bringing these regulations into effect is in various stages in various islands.

There has been little or no enforcement of the past or harmonized regulations in any island. Therefore, there is no way of evaluating the extent to which these regulations may reduce overexploitation and promote rehabilitation of the resource.

Population biology

Queen conch primarily inhabit sandy bottoms in sheltered areas where bottom disturbance and turbidity are low, and plant cover (seagrasses, macroalgae) is high. Although conch are considered to be most abundant in seagrass-bed areas at shallow depths, their habitat ranges from intertidal areas to depths of 60 m (200 ft). They are infrequent below 30 m (100 ft). At mid-depths they can be typically found on sand and algal plains. They are also known to occur on rubble covered bottom and, particularly at deeper depths, on silty sands. Small juveniles remain buried, and are thus associated with areas of less silty and less compacted sand. Juveniles are usually most abundant inshore, and move steadily offshore as they grow and mature.

Growth and mortality

Conch are herbivores. Adults and large juveniles feed mostly on benthic and epiphytic macroalgal species, particularly red algae. Occasionally, they eat seagrasses. Small juveniles rely on similar algal species, but probably also rely on detritus. Detritus may also be important for deep-water populations.

Conch growth is determinate; at the onset of sexual maturation they stop growing in shell length and produce their characteristic flared-lip. The lip increases in thickness with age. Average and maximum adult sizes vary widely among areas and are largely a function of environment. Estimated length at age for juvenile conch varies considerably among areas.

Conch shell weight and flesh weight continue to increase after the flared-lip is formed. Substantial increases in the thickness of the lip occur, and these can be used for aging. Growth in flesh weight occurs to a lesser degree than that of the shell weight. In Saint Christopher, a 35% increase in weight took place in one year after lip formation. In Puerto Rico a study showed that weight increase after lip formation occurred at a decreasing rate, so that an asymptote is approached. Little weight increase takes place after the first year past lip formation.

The oldest queen conch was aged seven years, from Bermuda. In warmer waters longevity should decrease, and on the basis of growth rates, is estimated to be six years in the USVI. Instantaneous mortality rates (M) have been shown to decrease with age such that adult conch can be expected to have a natural mortality rate of 0.8 or an annual survival rate of 45%. Mortality rates for juveniles will be higher.

Reproduction

Conch start to mature when they first produce their flared lip. The estimated age when this occurs varies between populations and may depend on the factors regulating growth. Values of 3-3.5 years are typical. Evidence based on gametogenesis, development of reproductive structures, and reproductive activity, clearly indicate that the ability to first reproduce comes at some time after lip formation. In Belize, there were no ripe gonads until lip-thickness reached a minimum of 4 mm. According to the rates measured in Puerto Rico, and Bermuda, this would take up to 3, 4 and 7 months, respectively, after complete lip formation, and 6, 7 and 14 months, respectively, from the beginning of lip formation. At Los Roques, Venezuela, first reproduction occurred 5 months after the start of lip formation or 2 months after its completion.

Males transfer sperm to females during copulation by extending their verge under the shell of females and into the genital region. Females may copulate with several males and store the sperm for several weeks prior to spawning. Given that many males can copulate with one female, egg masses can be fertilized by sperm from several males.

Gametogenesis occurs year-round in Belize; the actual spawning season was not documented. In other areas, definite seasons have been reported. Typically, spawning has been observed between March and November.

Conch produce demersal eggs, generally in areas of clean sand with low organic content. Females may take 24-36 hrs to lay a complete egg mass. Each egg mass contains between 300 000 and 700 000 eggs. At Turks and Caicos the

average female produces 8 egg masses over the 6-month spawning season, or over one egg mass per month. At Los Roques, Venezuela, maximum observed rates were 3 to 4 egg masses per month per female.

The eggs hatch in five days producing planktonic larvae. The length of the planktonic stage depends largely on available food, and also on temperature. In culture, larvae have metamorphosed in 2 weeks, although 3 weeks is the norm. Longer larval periods may be expected in nature if food is limiting. There appear to be upper limits on the duration of larval life. After 38 days the ciliary feeding mechanism of the larva starts to break down, thus limiting food intake. The longest reported period resulting in successful metamorphosis, again in culture, is 35 days.

Little is known about recruitment. In culture, competent larvae can be induced to metamorphose and settle by the presence of, or extracts from, red algae. In nature, the abundance of juveniles found in shallow areas would indicate that larvae are transported inshore where they are stimulated to metamorphose and settle when they come in close contact to appropriate algal species.

Assessment and management

One of the main impediments to evaluating the status of conch resources in the Lesser Antilles is a lack of data on landings, effort and the size of individuals in the catch. Establishment of data collections systems to acquire these data should be a priority (Mahon and Rosenberg, 1988).

There are several aspects of conch biology which complicate the application of standard assessment techniques to this species (Appeldoorn, in press). However, some assessment techniques could presently be applied, if due consideration is given to the implications of probable errors in input parameters. Other techniques would require considerable research. Which of these can and should be used depends on what can be enforced and the amount of money allocated for management.

Whereas it is evident that growth overfishing has taken place in most areas, and there is circumstantial cause for concern about recruitment overfishing, there is no hard evidence that the recruitment potential of the resource has been affected by the depletion which has taken place.

The most extensive assessments of queen conch in the eastern Caribbean have been for Puerto Rico and the US Virgin islands (Appeldoorn, 1987). These include estimates of natural and fishing mortality, yield/recruit analyses, and maximum sustainable yield estimates by general production modeling and by the product of yield/recruit and recruitment estimates.

Potential yield

Even approximate information on potential yield versus actual yield could be used as a guide to management.

There are many ways of estimating potential yield. These range from extremely data intensive approaches, such as yield/recruit analysis coupled with estimation of recruitment (surveys, stock/environment/recruitment models, backcalculation using current populations and mortality estimates) to extremely rough approaches, such as generalizing from one area to another.

Estimates of conch MSY from the Bahamas, USVI and Puerto Rico range from 0.03-0.1 t/km²/year (Appeldoorn, 1987). The value for the USVI (0.06 t/km²/year) has been applied to the island shelves and shallow banks of the Lesser Antilles (Appendix 1). This provides a very rough (order of magnitude) estimate of 1 200 t/year for the potential yield of conch from the entire Lesser Antilles, USVI excluded. Of this about 850 t/year would be from the OECS islands, Anguilla and Barbados.

In the case of conch, the possibility of applying general production models, which consider the combined effects of all population parameters, growth, mortality and recruitment, to estimate potential yields from island platforms is probably most constrained by habitat differences among shelves. The possibilities and problems of this approach are considered more fully by Mahon (1988).

Habitats

Conch larvae, juveniles, and adults are spatially segregated. Larvae are planktonic for about 3 weeks. Juveniles are very rarely found at sizes less than 10 cm, but are known to inhabit shallow coastal habitats such as seagrass and sandy bottoms in protected bays, where they remain buried in the substrate. As they grow older and larger they move gradually into similar habitats in deeper water.

Degradation or loss of seagrass and other inshore juvenile habitats would be expected to negatively impact recruitment of conchs to the fishery. Conch management therefore requires that these 'critical' habitats be protected. These habitats are usually threatened by tourist and urban coastal development. Resolution of these conflicts among different economic sectors is beyond a fishery management plan and should be pursued in the context of a coastal development plan.

MANAGEMENT OPTIONS FOR SHALLOW SHELF FISHES

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MANAGEMENT PLAN FOR SHALLOW SHELF FISHES

Introduction

Trap and line fin-fisheries in reef and associated habitats are among the most economically important in the Lesser Antilles. They provide relatively cheap protein and employ the majority of fishermen. However, these artisanal

operations seldom realize high incomes or returns to fishermen. They are not adequately supported by infrastructural facilities for harvesting, distribution and marketing, especially in those islands with offshore pelagic fisheries.

The potential importance of reef fish fisheries as a source of local protein and part time employment is frequently overlooked as fishery development focuses on expansion into pelagic resources. A primary objective should be the rebuilding of reef fish populations. Rehabilitated and properly managed, this resource is among the most likely to provide a continuous relatively stable yield which is easily accessible with a minimum investment in fishing gear.

Management objectives

Management objectives for rehabilitated reef fish fisheries could be oriented toward maintaining them as small-scale operations, or toward greater capital investment in more efficient technology. The latter might be easier to control, but would take place at the expense of those least able to acquire alternative employment, or afford alternative sources of food.

Assuming that management objectives would be toward maintaining small-scale reef fish fisheries, regulations which require a minimum of ongoing enforcement will be required. Given that the reef fish resource is already overexploited in most islands, the immediate objective of management should be to reduce fishing mortality, especially on juvenile fishes.

Problems for resolution

Policy is needed regarding the perceived importance of, and management intentions for, these fisheries.

Destructive fishing practices (e.g., dynamite, trammel and tangle nets) should be eliminated.

In most places, fishing effort should be reduced as quickly as possible in order to allow the stocks to rebuild.

In northern islands, ciguatera continues to impede full utilization of these resources. Continued efforts to determine the causes, and distribution of ciguatera, and to develop methods for its detection should be promoted.

Fishing by ghost traps continues to be a problem for which there is a ready solution -- biodegradable windows, and for which action should be taken.

Trap stealing is a serious problem in several countries. Apart from the direct impact on the fisherman through loss of catch, and frequently of the trap, there are two indirect effects. The first is the habitat destruction resulting from the use of grappling gear to recover traps set without buoys. The second is that stolen traps are usually discarded, thus contributing to the ghost trap problem.

Data are needed on catch, effort, species composition, and sizes of fish in the catch from which to determine the value of these fisheries. Such data are also required on an ongoing basis for monitoring the effects of regulations.

Management unit

Management units for shallow shelf (reef) fishes should be considered at two levels. The first relates to the distribution of juveniles and adults, and is therefore the island shelf. For most management measures, this will be the appropriate management unit. Where two or more states share a single shelf, joint management is indicated. The second level of management unit relates to the possible interaction of demersal stocks through planktonic early life history stages. Therefore, owing to the possible effects of overfishing in one area on recruitment to fished stocks in a neighbouring area, local regulations may have regional implications.

Current regulations

The use of dynamite is prohibited. The only other current regulations for shallow shelf reef fish fisheries are mesh size restrictions in some countries (e.g., 1.5" for Saint Christopher and Nevis).

Management options and implications

1. No action

With no management action, sustained high fishing effort will keep over-exploited reef fish stocks from recovering. In those islands with more extensive shelves, where resources may not yet be overexploited, increasing fishing effort, particularly in the form of larger vessels fishing farther from shore, will inevitably lead to overexploitation, reduced yields, and economic hardship.

2. Size/gear limits

Trap mesh size regulations may be the most appropriate step toward rehabilitation of this fishery. The mesh size could be selected with regard to both recruitment and growth overfishing, and to species composition. The rationale for and implications of these criteria are described below.

Regulations requiring fishermen to use larger mesh than they currently do should result in higher catch rates in the long term, but will result in lower catch rates in the short term. Thus, they will probably respond by increasing fishing effort. If so, the desired effect may not be achieved, or at least delayed considerably. The expected time for catch rates to increase would depend on the age at first capture of the various components of the catch. Consequently, extensive education of fishermen would be important, and some form of short term compensation may be required.

Biodegradable windows could be required in all traps in order to minimize the effects of lost traps on the resource.

Destructive fishing practices should be banned. These include the use of dynamite, which is already prohibited, and tangle and trammel nets which fish indiscriminately.

Gear regulations aimed at controlling the size of fish caught are feasible only for the trap component of the fishery, the hook and line component cannot easily be regulated in this way. If hook and line are, or become (several islands are encouraging the use of bottom set longlines), a significant component of fishing effort, limited entry may be the most feasible means of controlling fishing mortality.

3. Closed areas and seasons

The rationale for closed areas is that they provide reserves of mature individuals for egg production. The success of this approach will depend on the extent to which reef fish stocks are recruitment limited. Closed areas require clear marking, and if they are large, fishermen who used to fish them may be excluded by the distance which must be travelled to fish. Given that continuous maintenance and policing of closed areas will be required, they are probably only feasible when they also serve as marine parks for tourist use.

Seasonal closures can only be justified if spawning aggregations are targeted, or spawning is disturbed by fishing. Some species do form spawning aggregations (snapper, grouper, parrotfish) for which protection may be appropriate if the time and location is known. The extended spawning season generally attributed to reef fishes would reduce the impact of a closed season.

Most approaches to managing shallow demersal resources are based on the assumption that they will recover if fishing pressure is reduced. There is no guarantee that this will occur. It would be useful to close some heavily overexploited areas (e.g. west coast of Barbados) for several years to monitor the recovery of the fish populations.

4. Total allowable catch (TAC)

Assuming that these fisheries will be predominantly small-scale, TAC regulation will be virtually impossible to monitor and enforce.

5. Limited entry

If trap mesh-size regulations do not result in stock recovery, or cause unacceptable reductions in catch rates over the short term, it will be necessary to limit the total capacity of the fishery. Given the artisanal, small-scale nature of reef fish fisheries, limits on the number of participants in the fishery may be difficult to enforce. Ideally, this approach to management should be based on some estimate of potential yield from a given shelf area and of the catch taken per trap. Approaches to estimating potential yield in trap fisheries are discussed below. However, if it is clear that the resource is overexploited, it may be desirable to simply reduce fishing effort by a reasonable amount, say 20%, and monitor the catches.

If reduction in effort is impossible, all fishermen currently fishing should be licensed, and the reduction of fishing effort allowed to take place through attrition. By monitoring the catch rates, and size/species composition of the catch, it should be possible to detect the appropriate point at which to allow new entrants to the fishery.

6. Communal property rights

In islands where certain areas of shelf are fished primarily by a single community, probably those with narrow shelves, community-based management, in the form of community property rights to a specific area of shelf, may be feasible for these resources. In such a scheme, the community could decide on the appropriate measures for conserving the resource in their zone, and could be responsible for surveillance.

A community-based scheme assumes the existence, or initiation, of an organization within the community which, depending on the management approach to be adopted, could be responsible for determining who fishes, and how much. The community would require technical input as to appropriate levels of catch or other means of conserving the resource in their zone. Within island shelf areas, coordination among communities will be required to minimize disparity in approaches. With too much disparity, heavily overfished zones could drain well-managed adjacent zones.

The possible role of artificial reefs as a management tool was raised. The question remains open as to whether these structures enhance productivity, or simply aggregate fish, making them more susceptible to overexploitation.

The meeting noted that most options presented for ongoing management were relevant to traps only. Among the options, only limited entry was seen as a means of controlling line fishing effort.

Habitat conservation

Inshore habitats such as mangrove lagoons, seagrass beds, and estuaries are known to serve as nursery areas for juveniles of many species of shallow shelf reef fishes. Continued destruction and degradation of these habitats by coastal development and by nearshore pollution can be expected to impact on the yields from these fisheries. The importance of coastal habitats for these fisheries should be emphasized in the coastal zone planning and management process.

The reef habitat inhabited by the adults are also subject to destruction or degradation in many ways. The use of dynamite for fishing is one extremely destructive practice, and current regulations prohibiting its use should be rigorously enforced.

Regional implications

For stocks which are shared through the interchange of resident individuals (e.g., shared shelves) the situation is more complex. Any island attempting to manage only its portion of a shared stock will not have the necessary information. Assessments using incomplete data will be potentially erroneous and could lead to inappropriate regulations. Inequality in management of the parts of a shared stock could result in draining the resource from the better managed area. As fishermen become aware of the inequality, enforcement within the more conservative fishery will be difficult. Thus, management of these stocks requires cooperation in data collection, stock assessment, research, and management.

Certain types of assessment will require a comparative approach throughout the region, thus allowing the entire region to benefit from the expertise of a small group.

Action summary

Short-term (1-3 years)

Monitoring systems for catch, effort, species and size composition, should be established immediately.

The use of trammel and tangle nets should be prohibited because they are destructive.

The problem of ghost traps should be addressed by requiring that traps be equipped with a biodegradable panel.

Dynamiters should be prosecuted to the full extent of the law. Trap mesh size should be regulated at the current size or 1.5 inches, whichever is greater.

Medium to long term (3-10 years)

In islands where overexploitation is evident, licensing of fishermen should be considered and the reduction of effort allowed to take place through attrition.

Depending on the availability of funds, programs to provide island specific estimates of the status of the resource, and of potential yield should be initiated.

Other relevant research would include: studies of size at maturity for common species; trap mesh selectivity studies; trial closure of the largest feasible areas for 3-5 years with close monitoring.

SUPPORTING MATERIAL FOR SHALLOW SHELF FISHES

Species composition

All species of fishes large enough to be retained by the meshes of the traps are caught and utilized. The species composition of the catch varies among habitats and with the degree of exploitation. In areas which have not been badly overexploited, snappers, groupers, and large parrotfishes may contribute significantly to the catch. In heavily exploited areas, only a few families contribute most of the catch (squirrelfishes, grunts, surgeonfishes).

Stock structure

All exploited reef fishes have planktonic early life history stages. The question of whether extensive dispersal takes place during this period, or whether the time and place of spawning is selected to maximize return of recruits to parent populations remains unresolved. Once they have settled, reef fishes remain in association with the substrate, and are sedentary. Therefore, exchange of demersal juveniles and adults between island shelves is probably negligible.

The Expert Consultation on Shared Fishery Resources of the Lesser Antilles concluded that, in one country per shelf situations, independent management could be undertaken with reference to local socio-economic requirements. However, given the possibility of larval exchange, spawning stock biomass levels should be maintained. In shared shelf situations demersal stocks are probably transboundary, and co-operative management will be required (Mahon, 1987).

Fisheries

General status

Although in some islands, handlining and spear fishing take appreciable proportions of the catch, traps are the main gear for reef fishes and typically harvest numerous species simultaneously. This is a problem, since these species usually differ in their biological characteristics and therefore

their response to exploitation. The level of fishing or gear size which may be optimal for one may severely overexploit another. Consequently, the composition of the reef fish community and hence of the catch, may be substantially altered by exploitation. Traditional single species assessment and management methods are not easily transferable to such multispecies fisheries, although some variations may be applicable. Appropriate methods are currently being developed at various centers, but they have not been tested in practice.

Trap and handline fisheries for shallow reef fish species are characteristically artisanal with the catch being landed at a large number of sites and consumed locally. The fishermen are often part time. Since most island shelves are narrow, the distance travelled by boats is short and the boats are small (4-8 m), open and outboard engine powered (8-48 hp). In some islands with large shelf areas (Antigua/Barbuda, Grenada) larger, inboard powered sloops are also used. Details of the characteristics of the fleets, types of gear, fishing practices, and distribution patterns for most of the Lesser Antilles (except, French, Netherlands, and USVI), can be found in Mahon and Rosenberg (1988). Despite the apparent undeveloped nature of the fishery, it is widely accepted that reef fish resources are overexploited. The evidence is the absence of large individuals from the catch, the scarcity of some of the larger species (e.g., snappers, groupers, parrotfishes) from the catch and an acknowledged reduction in abundance on traditional fishing grounds.

Ciguatera

Ciguatera is an important concern in shallow-water reef fish fisheries. Dog snapper and yellowfin grouper are notorious for poisoning. In some areas large snappers and groupers are not sold because of the risk of ciguatera. In the Lesser Antilles, ciguatera is not frequent at islands further south than Montserrat.

Current management

There are no regulations currently controlling the exploitation of shallow shelf fishes in the eastern Caribbean. The use of dynamite is prohibited but this regulation is not widely enforced.

Population biology

Growth and mortality

Methods for the study of growth in tropical fisheries have only become well established (otolith daily growth rings), and available (length frequency analysis software) over the past decade, and are gradually being applied to exploited species. Although there are no reviews of the size composition of the catch from reef fish fisheries, rough generalization is possible from the FAO identification sheets and the few compilations of growth which are available. The species caught from shallow shelf habitats commonly range in size up to about 50 cm, although maximum size of many species may be greater (Munro, 1983, Ch. 19).

There is less available information on longevity of the harvested species which probably ranges from about 4-6 years for the smaller species (surgeonfishes, squirrelfishes, goatfishes) to greater than 10 years for the larger ones (snappers and groupers).

Reproduction

Most reef fishes have planktonic eggs and larvae. Reef fishes may select spawning locations and times which maximize the return of young to the natal area by currents and there is likely to be variability among species and locations as regards the extent of dispersal.

Although most species appear to have extended spawning seasons, and ripe individuals may occur year round, there are two peak periods of spawning activity for Caribbean reef fishes, the largest around March-April, and a smaller one in October-November.

Larval distribution of commercially important reef fishes is not well known. The length of time spent in the plankton varies considerably for those families which have been studied: 15-121 days in wrasses (100 species), 25-50 days in snappers (3 species), 35-50 days in groupers (2 species) (Leis, 1986; Victor, 1986).

The patterns of settlement of juvenile reef fishes from the plankton to demersal habitats has been the subject of considerable recent study. The question of whether the abundance of reef fish populations is generally limited by the availability of recruits, or by the availability of space and food after settlement remains to be resolved (Mapstone and Fowler, 1988).

Assessment and management

Monitoring

An essential part of any attempt to regulate will be appraising the impact of the regulation on the resource. For this, monitoring of trends will be essential. Since most assessment methods are largely untested in tropical multispecies fisheries, confidence in the calculated values will be low and trial and error will probably prevail in arriving at the right management measure. Establishing monitoring capability should be a significant component of any project aimed at managing trap fisheries. Engaging the cooperation of fishermen in this activity would probably be the cheapest method.

Growth overfishing and yield/recruit (Y/R)

The aim is to optimize yield/recruit by allowing the average fish to live long enough to complete periods of rapid initial growth. This could be approached through yield/recruit analysis. However, the input requirements for such analysis are considerable and simple visual examination of the growth curves of the key species may allow determination of the current average size of fish in the catch compared with the inflection point in the growth curve.

The information required for traditional yield/recruit analysis is: size at age (growth), natural mortality and the pattern of recruitment to the fishing gear. For ease of computation, understanding and the flexibility to accommodate complex recruitment patterns, the method of Thompson and Bell is preferable over that of Beverton and Holt. The former is particularly useful for a trap fishery where the recruitment pattern is likely to first increase with fish size then decrease. Of these input parameters, natural mortality is the most difficult to estimate.

A problem with using the information from the analysis to regulate mesh size is knowing the selectivity of various mesh sizes for various species. This is essential for the yield/recruit analysis. Simply acquiring this piece of information would be a fairly sizeable but important field project.

Yield/recruit analysis has been conducted on some important species in various parts of the Caribbean (Appeldoorn, Dennis and Monterossa López, 1987). As a first approximation, this information may be appropriate for use in the Lesser Antilles. However, as growth, mortality and recruitment to the gear may vary geographically, such studies should be promoted in the fishery to be managed. Due to their multispecies nature, yield/recruit optimization for reef fish fisheries will be technically or computationally complex, even if yield/ recruit analyses have been tested in practice. Therefore, consideration should be given to qualitative aspects of the fishery such as species composition.

Recruitment overfishing

If unexploited reef fish populations are limited by recruitment (see reproduction above), recruitment overfishing may be significant in the depletion of reef fish stocks. This will be particularly true if there is a strong correlation between the numbers of eggs produced (spawning stock size) and the number of recruits available to settle. Alternatively, if the numbers of recruits are more determined by events taking place during the planktonic period than by the initial number of eggs spawned, recruitment overfishing may not take place until low spawning stock biomasses are reached.

Full prevention of recruitment overfishing requires knowledge of a stock recruitment relationship. This information is unlikely to become available in the foreseeable future, but a simple first step is to prevent the harvesting of immature (juvenile) fishes. In this case, size at maturity would be the basic information received, the aim would be to protect the spawning stock, and mesh size could be regulated for this objective. Again, as the fishery is multispecies, the resulting range in size-at-maturity, will require compromises.

Marine reserves and closed areas may have an important, but as yet unevaluated role to play in providing sources of recruitment.

Control of species composition

Since the trap fishery is multispecies and the species vary considerably in size and growth rate, the species composition of the resource assemblage and thus of the catch is likely to be affected by exploitation. This effect has recently been documented for the Pedro Bank and Port Royal Cays off Jamaica (Koslow, Hanley and Wicklund, 1988). Controlling mesh size should affect both the size and species composition of the catch. Eventually, as information accumulates on growth and size at maturity for the major species, it should be possible to regulate mesh size with species composition in mind. Again this can be done formally through multispecies yield/recruit and stock recruitment analyses, but the data requirements will almost certainly dictate an ad hoc, commonsense approach in the short term.

Passive effort control

Accumulating the fishery statistical databases and carrying out the supporting research required for assessments of the type discussed above will take several years. Moreover, there are many reasons to expect that trap mesh size regulation will not result in rehabilitation of overexploited reef fish populations. Some means of controlling total fishing effort will be required.

In those cases where it is obvious that the resource is overexploited, immediate action is warranted. This could involve the licensing of trap fishermen and limiting the numbers of traps fished per fisherman, then allowing the gradual reduction of fishing effort through attrition, as fishermen leave the fishery and surrender their licences. The response of the resource to this reduction should be followed by monitoring. This should allow determination of the appropriate level at which to stabilize effort.

Estimating potential fish yield from island shelves

The question of estimating the yield of reef fishes has frequently been raised as a high priority research item in the Caribbean. From the above, it is not clear that such estimates are necessarily required before significant management measures can be implemented. While research aimed at establishing appropriate trap mesh sizes, and potential yields are in progress, the process described under "Passive effort control" should be implemented.

Estimating the potential yield of the resource in order to limit fishing effort (number of fishermen/traps) to that required to catch the estimated yield, could be a supplement to, or refinement of the immediate action suggested above. The situations under which the estimates may be most useful in the short term would be those island shelves where the resource is not considered to be overexploited, and where estimates of the scope for expansion are needed for development purposes. However, even in those islands, it seems unlikely that any substantial increases in effort will be appropriate.

The rest of this section outlines approaches to estimating potential fish yield from island shelves. For completeness, four approaches are considered: (1) using data from elsewhere in the world to arrive at rough estimates; (2) biomass surveys; (3) multispecies yield/recruit modelling coupled with recruitment estimation and (4) general/surplus production modelling.

Estimates of yield per unit area of tropical shelf from other areas are variable. In general they range from about 0.5-5.0 t/km²/year. Values up to 18 t have been recorded (Marten and Polovina, 1982; Caddy and Sharp, 1986). This variability could be due to, real differences in productivity in similar habitats, differences in habitat composition, differences in extent of exploitation, and/or differences in species included in the estimate. In Appendix 1, the range of estimates shown above is applied to island shelves and shallow banks in the Lesser Antilles. The resulting estimates of total yield (USVI excepted), range from about 10 000 to 100 000 t/year. This range is clearly too wide to be useful for planning purposes.

Biomass surveys are most useful in the case of an unexploited resource. If the virgin biomass can be estimated, the "rule of thumb" where potential yield equals half the virgin biomass, times the natural mortality can be applied for the rough estimate to be used in planning. This approach will not be useful for trap fisheries in the Eastern Caribbean as they are already heavily exploited.

The yield/recruit route to estimating potential yield is the most complex. It involves all the problems relating to multispecies yield/recruit discussed above, as well as the problem of estimating the incoming recruitment of all the species involved. This would require a huge research effort.

General production modeling is likely to be the most appropriate method. In its usual form, this approach requires several years of catch and effort data at various levels of effort. Such time series do not currently exist, and given the present levels of effort in the island fisheries, obtaining data for a variety of levels of effort in any one island would be very difficult. The only feasible approach to a general production estimate of potential yield would be to use each island as a separate catch and effort data point (Caddy and Garcia, 1982), as was done for the parishes of Jamaica (Munro, 1978, 1983). For this method to work, there would have to be variability among the islands in the amount of effort (fishing mortality) being exerted on the stock. This could be measured as effort per unit area, or directly as fishing mortality. There are a number of complicating factors which would make the practical application of this approach difficult. Differences in habitat composition, which would require mapping, and differences in gear used, which would require intercalibration. These are considered in greater detail by Mahon (1988).

Habitats

Throughout the eastern Caribbean, there is evidence that urban, industrial and tourist development is having significant negative impacts on coastal marine habitats. In certain instances, these impacts are becoming evident on offshore reefs as well (Hunte, 1988). Degradation and destruction of coastal marine habitats in the Lesser Antilles is potentially problematic for shallow shelf reef fish resources from two aspects. The first is that many of the most threatened habitats, close to shore, such as mangroves and seagrass beds, are important nursery areas for juveniles of harvested reef fishes. Reduction in the amounts of these habitats may result in a recruitment bottleneck for reef fish populations, similar to that already considered to be limiting to lobsters.

The second aspect is that of the adult habitats. Loss of live coral, and other changes in reef structure leading to loss of cover and diversity can be expected to reduce the abundance of harvested species.

MANAGEMENT OPTIONS FOR DEEP SLOPE AND BANK FISHES

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MANAGEMENT PLAN FOR DEEP SLOPE AND BANK FISHES

Introduction

The fisheries for deep slope and bank fishes are typically trap and hand line. The catch is almost entirely snappers and groupers. These fisheries

can be mechanized using electric reels and trap winches, which are standard in the southeastern USA and in some other parts of the Caribbean region. In general, this fishery requires larger, better equipped boats than the reef fish fishery.

The fishery biology of the species which comprise the catch is poorly known in the Caribbean, although snappers and groupers have received the most attention among demersal fishes. Most have planktonic early life history stages which may or may not disperse between islands. Dense spawning aggregations at predictable locations are known for several of these species. At such times these species are particularly vulnerable to exploitation.

Management objectives

The objective of management for these species could be to maximize catches for sale to restaurants and hotels, and for export, without overfishing the stocks, and while conserving the small-scale nature of the fishery. Conservative development may be required to maintain good stocks of preferred species.

The harvesting sector could be developed in either of two directions, or as a mixture of the two. The first direction would be to leave exploitation to the existing small scale fleets, using handlines, some traps and palangres (bottom set long lines). Alternatively, more efficient exploitation of these resources could be encouraged. This would involve appreciable capital investment in a few boats (10-15 m) and electric reels or trap haulers. In the latter case regional cooperation may be required in order to support several such vessels.

The extent to which development is promoted in either of these directions may depend on the accessibility of the slope and bank fishing areas to small-scale fishermen, that is, the width of the island shelf and the distance of offshore banks.

Problems for resolution

Policy is needed regarding the appropriate direction (small-scale, commercial, combination of the two) for the development of the fishery.

Data collection systems for catch, effort, species composition and fish sizes are needed before fishing effort increases significantly.

Management unit

Management units for deep slope and bank fishes should be considered at two levels. The first relates to the distribution of juveniles and adults, and is therefore the island shelf or bank. For most management measures, this will be the appropriate management unit. Where two or more states share a single shelf, joint management is indicated. The second level of management unit relates to the possible interaction of demersal stocks through planktonic early life history stages. Therefore, overfishing in one area may reduce recruitment to fished stocks in a neighbouring area.

Current regulations

There are no regulations currently controlling the exploitation of deep slope and bank fishes, but in some areas licences limit areas where larger mechanized vessels may fish.

Management options

1. No action

Given the limited amount of deep slope and bank habitat, and therefore the limited potential yield, this resource is likely to become quickly overcapitalized and overexploited. Although deep slope and bank fishes are probably underexploited in most of the Lesser Antilles, the experience of Puerto Rico and the USVI supports the above prediction.

2. Size/gear limits

In any one place, the catch tends to be dominated by 4-5 species, and size limits aimed at reducing growth and recruitment overfishing may be appropriate. However, note that size limits may serve only to control the size of landed fish and may result in considerable discarding at sea. Since these fishes are caught in deep water, most discards will die and the regulation will be ineffective.

To limit the size of fish caught in these fisheries, it will be necessary to investigate relationships between gear characteristics (hook size, mesh size) and the size of the fish caught and to regulate the gear which can be used.

Enforcement of these measures will be easier if the fleet is comprised of commercial vessels rather than small-scale artisanal vessels.

3. Closed seasons and areas

Many of the species caught in this fishery are known to aggregate for spawning. If the fishery is targeting these aggregations, high fishing mortalities can be exerted on an entire stock in a short period. Under these circumstances, closing the fishery during the spawning period may be appropriate. Note however, that this reduces the efficiency of capture and thus raises the cost of fishing. Ideally, fishing should be allowed at the time when catch rates are highest, and fishing mortality controlled by a TAC. Unfortunately, this approach will not be practical in the case of dense aggregations, unless there are precise estimates of how many fish should be taken, and there are observers on board the vessels.

If a combination of small-scale and larger mechanized vessels is to be used in order to fully exploit the resource, designated fishing areas may be required in order to minimize conflicts between these two fleet components.

4. Total allowable catch (TAC)

The extent to which TAC regulation will be feasible for deep slope/bank fisheries will depend largely on whether the catch is taken by a few commercial size vessels landing at a few processors, or by numerous small-scale fishing units landing at widely dispersed points. In the latter case, the costs of monitoring and compiling the catches will be prohibitive.

In principle, TACs can be set on the basis of past catches, or other inexpensive estimates. However, if TACs are the same from year to year, flexibility, one of the main advantages of the system, is lost. This flexibility allows TACs to track stock abundance.

To allow flexibility, data intensive, technically sophisticated, on-going stock assessments would be required. The cost of these might not be justified by the total value of the fishery.

5. Limited entry

Given the relatively high price of these resources, overcapitalization will probably occur in spite of measures such as gear limitations and closed seasons. Under these circumstances, it may be necessary to limit the number of vessels which can participate in this fishery, particularly if this can be done during the development phase of the fishery.

6. Communal property rights

The applicability of community based management in these fisheries will depend on the relative emphasis on small-scale versus commercial development. This in turn will depend on the proximity of the slope and banks to fishing communities (width of shelf) and their accessibility using small vessels.

Habitat conservation

Inshore habitats such as mangrove lagoons, seagrass beds, and estuaries are known to serve as nursery areas for juveniles of many of the species caught on the deep slopes and banks as adults. Continued destruction and degradation of these habitats by coastal development can be expected to impact on the yields from these fisheries. The importance of coastal habitats for these fisheries should be emphasized in the coastal zone planning and management process.

Regional implications

Any assessment programme for these species should be carried out on a regional basis, in order to be both cost effective, and to use a comparative approach as discussed under assessment below. The possibility of developing a mechanized commercial fishery for these species using mid-size vessels (15-20 m) to provide safe access to offshore banks, and inaccessible areas (such as rough east coast slopes) could be considered at a regional level.

Action summary

Short-term action (1-3 years)

Policy decisions should be made regarding the nature of the development of fishing fleets and gear.

Monitoring systems for catch and effort data as well as for length frequency samples and species composition should be established immediately.

Current rough estimates of potential yield should be reviewed and revised in the light of information from similar habitats and assemblages elsewhere.

Medium to long-term action (3-10 years)

Resource assessment activities should be undertaken with the aim of providing more accurate estimates of potential yield, and of the impacts of exploitation on reproductive potential.

SUPPORTING MATERIAL FOR DEEP SLOPE AND BANK FISHES

Unless otherwise referenced the information contained in this section is summarized from Appeldoorn, Dennis and Monterossa López (1987), and Polovina and Ralston (1987).

Species composition

In the Lesser Antilles the deep-water catch is primarily composed of silk snapper, blackfin snapper, and misty grouper. Blackfin snapper are most abundant between 55 and 95 m (30 to 50 fm), whereas silk snapper are more abundant deeper, from 165 to 210 m (90 to 115 fm). Other species, such as vermillion or black snapper, may occasionally be taken in large numbers, but rarely make up more than 1% of the catch.

Stock structure

Due to the relatively sedentary nature of adult snappers and groupers, dispersal between major island groups over water depths greater than 700 m would be by planktonic early life-history stages. A planktonic existence of one to two months would provide ample time for dispersal by currents to other islands.

Spawning aggregations of snappers and groupers are common, and may facilitate synchronization of reproduction with oceanographic conditions that would return offspring to the island of origin.

The large number of snappers or groupers in a spawning aggregation compared to their usual density on reefs suggests that they travel great distances to spawning sites. In the case of the Nassau grouper only one assemblage is known from each of the islands in the Cayman group, indicating that all Nassau groupers on an island migrated to the single aggregation site, perhaps up to 50 km.

Another common characteristic of snappers and groupers is the tendency for juveniles to prefer shallow waters, and adults to be more common in deeper water. On islands with extensive shelves, such as Anguilla or Antigua/Barbuda, this could involve a relatively long distance migration. However, little is known about the mechanism and timing of the migrations. A further puzzle is how snapper/grouper assemblages develop in deeper water or on offshore banks, such as Saba bank, which lack nearby shallow water habitats.

In summary, based on the limited knowledge available, both snappers and groupers apparently have long enough planktonic stages to disperse among islands, but currents around Lesser Antillean islands may sometimes favour the retention of locally spawned individuals. This suggests some sharing of a common gene pool among island populations, but from the fishery management perspective, discrete island stocks dependent on locally spawned recruits may exist.

Fisheries

General status

The snapper/grouper fisheries in the Lesser Antilles have been somewhat depth limited by the fishing gear used and artisanal state of the fishery. Since World War II, untapped resources were thought to lie in deeper waters of

the Caribbean. In the late 1960s and early 1970s the FAO/UNDP surveyed deep-water resources throughout the Caribbean to determine their location and potential.

Snappers and groupers dominated the exploratory deep-water trap fishing of the UNDP/FAO project, comprising from 43 to 92% of the catch by weight in the Lesser Antilles. CPUE was greatest from Antigua to Montserrat and from Trinidad and Tobago; lowest CPUE was in the southern Lesser Antilles from Guadeloupe to Grenada including Barbados.

Hook-and-line catch (bottom longline, snapper reels, and hand lines) was almost exclusively snappers and groupers, with the highest CPUE in the northern Lesser Antilles (north of Montserrat). More incidental species (e.g., small pelagics) were caught and lower CPUE was evident in the southern Lesser Antilles.

Ciguatera is relatively uncommon among the species captured in deep water fisheries. Although deep-water snappers and groupers are, on average, larger than their shallow-water counterparts only the misty grouper has a bad reputation for ciguatera.

Current management

There are currently no management regulations or programs for the fisheries of deep slope and bank areas in the Lesser Antilles.

Population biology

Snappers and groupers grow quite large (many greater than one metre in length), are slow growing and long-lived; life-history characteristics which make them susceptible to overexploitation. Several species are hermaphroditic, a feature which has considerable implications for their response to exploitation (see recruitment overfishing below). Spawning is assumed to occur in the water column and eggs are fertilized externally. Eggs of both groups are about 1 mm in diameter and are probably planktonic.

Grouper eggs have been observed to develop and hatch in 27 to 40 h. Larvae of both groups are planktonic. Juveniles settle to the bottom at sizes as small as 10 to 20 mm SL. Estimated monthly growth rates of 10 to 15 mm for juveniles indicate that newly settled individuals would be one to two months old. Lutjanid and serranid larvae have been taken far offshore in the Caribbean Sea, but in very low numbers.

Many commercially important snapper/grouper species form large spawning aggregations. These aggregations indicate that the majority of spawning may take place over a short period. Aspects of spawning aggregation relevant to stock structure and the definition of management units have been discussed under that heading above.

Assessment and management

Growth overfishing and yield/recruit (Y/R)

Since only, four to five species comprise most of the catch in any one place, yield/recruit analysis may be a feasible approach to determining if growth overfishing is taking place, and to setting size or gear regulations. Application of standard yield/recruit methodology to tropical fishes has been hampered by problems with age determination which have made it difficult to

meet the model requirements for size at age, or growth curve parameters. Recent methodological developments using length frequency data have provided ways around this problem. These methods have been used for snapper/grouper resources in the Pacific, but there has not been sufficient time to determine if the results were accurate.

Recruitment overfishing

The sexual system in groupers is relevant to the question of recruitment overfishing in groupers. Although all commercial snappers are apparently gonochoristic, most if not all western Atlantic groupers are protogynous hermaphrodites (change sex from female to male at larger sizes). Fishing mortality can reduce the mean size in a population, thus reducing the number of males. The potential impact on recruitment depends on several factors. If the availability of males is a limiting factor for successful reproduction for many females, and if sex change is controlled by age (or size), a heavily fished stock may not be able to compensate for the reduction in number of males. Thus, reproductive success may be reduced in a heavily fished stock, and could lead to recruitment failure. Alternatively, if sex change is behaviourally controlled, then the removal of males by fishing may cause females to switch sex to retain an ideal sex ratio, thus having no effect on reproductive success.

Potential yield

Estimates of potential yield would be useful in setting targets for fishery development, and in due course for setting limits of allowable effort. In the first instance, even crude estimates with a range of values might be useful. For latter requirements, more refined estimates will be desirable. These could be approached in several ways.

There has been one estimate of potential yield per unit length of slope in the Caribbean (Pedro Banks), but this was based on observed catches at unknown exploitation rates. Even if accurate it might not be applicable to the eastern Caribbean. Another rough estimate of yield could be obtained by applying the results from an assessment program in the Marianas Archipelago to the perimeter distances of the islands shelves and banks in the Lesser Antilles. This has been attempted in Appendix 1. The resulting minimum and maximum estimates are about 450 and 2 000 m/year for the entire Lesser Antilles, excluding the USVI. The true value is probably closer to the lower end of the range.

Assuming an average annual catch of about 30-40 t for a mechanized vessel about 15 m in length (Poffenberger, 1985), the above potential yield would suggest a fleet size of 15-60 vessels. Considering that the estimate of potential yield is probably closer to the lower end of the range, about 700-800 t/year, the appropriate fleet size would be in the vicinity of 20 vessels. If it is assumed that small-scale fisheries will be taking about half the catch, then a commercial fleet of only 10 vessels could be accommodated.

Similar calculations for non US or EEC States (OECS Member States, Barbados) alone gives a yield range of 250-1 100 t/year, probably close to 400 t/year. This could be taken by about 12 vessels, or if half the catch is taken by small-scale fishermen, six vessels. Thus, the scope for development of such fisheries in the Lesser Antilles is not great. Depending on the fishing patterns of some of the launch type vessels beginning to appear in the Lesser Antilles (Mahon, 1988), fishing capacity may already be at or close to

Refinement of the above estimate is clearly important if the development of excess effort is to be avoided in these fisheries. Surplus production models may be applicable, but would require several years of catch and effort data, unless the spatial version of the surplus production model were applied. The concepts and problems with this approach are discussed more fully in the plan for shallow reef fish resources. As similar considerations apply, this would be a substantial assessment undertaking.

An even more detailed approach is that used to assess similar resources in the Marianas Archipelago (Polovina and Ralston, 1986). This approach assumes that the resource is unexploited, an assumption which can be relaxed if fishing mortality can be estimated. The feasibility of applying this approach will depend on the availability of expertise for analysis and funds for field assessment activities.

Habitats

Inshore habitats such as mangrove lagoons, seagrass beds, and estuaries are important nursery areas for juveniles of many of the species which are caught on the deep slopes and banks as adults. Continued destruction and degradation of these habitats by coastal development can be expected to impact on the yields from these fisheries. The importance of coastal habitats for these fisheries should be emphasized in the coastal zone planning and management process.

MANAGEMENT OPTIONS FOR LARGE PELAGICS WITH STOCKS EXTENDING OUTSIDE THE LESSER ANTILLES REGION

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MANAGEMENT PLAN FOR OCEANWIDE LARGE PELAGICS

Introduction

Offshore pelagic resources are generally considered to hold the greatest potential for development and most islands are attempting to increase the effort in these fisheries. The catch consists of several species with a wide variety of life histories: tunas, billfishes, dolphin, wahoo, kingfish, sharks. These fishes are usually exploited on the same fishing trips, often together with flyingfish, by boats ranging from canoes with outboard engines (Saint. Lucia, Dominica) to larger inboard powered launches with ice containers (Barbados). Although the composition of the catch varies from island to island, dolphin, yellowfin tuna and wahoo are the most important large pelagics.

Although they comprise a single fishery in most places, these fishes vary widely in distribution, migratory patterns and in their potential for development. Following the conclusions reached in the Expert Consultation on Shared Fishery Resources of the Lesser Antilles, these species are considered in two groups: those for which stocks are probably contained within the Lesser Antilles region (for example dolphinfish, kingfish, wahoo, blackfin tuna); and those for which stocks extend throughout the Atlantic, or at least the western Atlantic (for example, yellowfin tuna, skipjack tuna, billfishes and swordfish). The latter group are considered in this plan.

These species are assessed by ICCAT, but the status of the stocks, especially in the western Atlantic where the data base is weak, is poorly known. Without substantial investment in large purse seine or longline vessels, the yellowfin catch of Eastern Caribbean countries will probably remain an insignificant proportion of the total catch.

Management objectives

Management should be oriented toward developing the capacity to maximize catches of large pelagic fishes inhabiting or migrating through the EEZ. This should be done with reference to the current status of stocks. Stock status is largely determined by exploitation by other nations fishing primarily on the high seas, and in other EEZs.

Two non-exclusive development/management options are: encourage investment in commercial longline and purse seine vessels; or emphasise the harvesting of these species by improved technology on smaller craft. Following both lines will ultimately bring these components of the fleet into conflict, unless provisions are made to keep them apart. If small craft enhancement alone is followed, large areas of the EEZs will not be accessible. If commercial development alone is promoted, undesirable socioeconomic repercussions will be felt in many coastal fishing communities.

Access to offshore areas of the EEZs could be achieved by regional investment in a few commercial vessels, by joint venture, or by licensing foreign vessels. This could be pursued while reserving fishing grounds which are accessible by local craft for local fisheries. This assumes that unpermitted fishing by foreign vessels will be brought under control.

The value of actively promoting recreational fisheries for these species in the region should be considered.

Problems for resolution

Policy is needed regarding the nature of the fleet to be developed to utilize the pelagic resources occurring in the EEZs of the region. This includes policy relating to the perceived role of recreational fisheries, which can be important foreign exchange earners.

Unpermitted foreign fishing continues to be a major problem. Effective utilization of the resources available to the islands of the Lesser Antilles requires that foreign fishing be controlled.

Data on catches and fishing effort are needed in order to evaluate the value of the fishery, and to assess changes which may take place as the fishery develops.

The expertise and experience required for participation in the activities of ICCAT is needed in order that the regional interests be represented there, and that the region benefits from the information which is available through ICCAT and through contact with other ICCAT Member States; in particular the Fishery Management Councils of the USA.

Management unit

For most of the species, the management unit will be as proposed by ICCAT, either western Atlantic or entire Atlantic Ocean.

Current regulations

There are no regulations for these species within Lesser Antilles countries, and minimal regulations proposed by ICCAT. The latter are minimum size limits for yellowfin and bigeye tuna.

Management options and implications

Management measures implemented by Eastern Caribbean countries are unlikely to have any significant impact on the status of these resources. At best, these islands could attempt to influence the management of these resources by becoming involved in the activities of ICCAT. An appropriate strategy would be to catch as many fish as are available to existing fleets and to continue acquisition of technology for efficient harvesting, but not to base extensive fleet expansion on expectations of increasing catches from these species.

Habitat conservation

There are no well documented habitat conservation considerations for these species. However, recent events relating to possible offshore dumping of toxic wastes in the Caribbean give cause for concern and vigilance.

Regional implications

The strategy outlined in this document assumes that there is a regional organization which will compile, analyse and interpret the catch, effort and related data from the regional viewpoint. Involvement in ICCAT activities would also have to be at the regional level, and the representative(s) or observer(s), as the case may be, would need formal mechanisms through which to receive input on regional priorities and to provide feedback.

ICCAT maintains databases on the species for which it is responsible, and holds annual meetings at which new analyses are presented and the assessment and management of the various species discussed. Access to the databases could provide information on distribution and catch rates in this region which is not available from the reports. The data in the database are often in a detailed form, but have not been analysed with a view to addressing problems of eastern Caribbean countries. Participation in the workshops and annual meetings would provide essential contact with other scientists working on the same species. This would keep regional scientists up to date on the techniques being used. Finally, the meetings would facilitate contacts with scientists and administrators from extraregional countries with fleets fishing in this area. A considerable amount of useful qualitative information would be expected from these informal contacts.

Action summary

Short term (1-3 years)

Countries should decide on a development policy for offshore pelagics: commercial, small-scale, recreational, or combinations thereof, including measures for resolving potential conflicts.

Monitoring systems for catch and effort data by species, as well as for length frequency samples should be established immediately. Representative(s) from regional institution(s) should be designated to participate in ICCAT activities. This would facilitate the exchange of information between the region and ICCAT, and provide the region with access to the current methodology for assessment and management of these species.

The current emphasis on reducing unpermitted fishing through regional cooperation in surveillance and enforcement should be continued.

The current preliminary estimates of potential yield should be reviewed and revised using all available information from tropical pelagic fisheries. This estimate should include upper and lower limits. The difference between this estimate and current catches would give some indication of the scope for development within the EEZs of the region.

Medium to long term (3-10 years)

Catch rates within the region should be used to evaluate the scope for further expansion. This should be viewed in the context of large scale assessment of stock status and potential carried out by ICCAT.

SUPPORTING MATERIAL FOR OCEANWIDE LARGE PELAGICS

Unless otherwise referenced, the information presented below is summarized from papers in the Report and Proceedings of the Expert Consultation on Shared Fishery Resources of the Lesser Antilles (Mahon, 1987; Hunte, 1987; Mahon and Mahon, 1987), the most recent ICCAT Report (ICCAT, 1987), the background document for the CFMC management plan (Centaur Associates, 1983), the skipjack year program (Symons, et al., 1986), and the swordfish workshop. Detailed information is provided for the major species only.

Species composition

The tunas which contribute most to the catch in this category in the Lesser Antilles are yellowfin tuna (Thunnus albacares), skipjack tuna (Katsuwonus pelamis) and to a lesser but poorly documented extent, bigeye tuna (T. obesus). Albacore (T. alalunga) are caught mainly in the northeastern islands.

The billfishes most often mentioned in accounts of fisheries in the eastern Caribbean are the blue marlin (Makaira nigricans) and the Atlantic sailfish (Istiophorus albicans). These two species support valuable recreational fisheries and contribute to the catch of multispecies artisanal fisheries for pelagics. White marlin (Tetrapterus albidus) and longbill spearfish (T. pfluegeri) also occur in the eastern Caribbean but contribute much less to the catch.

Swordfish (Xiphias gladiator) is a particularly important species in this category having recently been the focus of a shift in targeted effort from the eastern USA to the Caribbean region.

Stock structure

Final resolution of stock structure for most large pelagics will be very difficult. Even for the commercially important tunas, ICCAT scientists have been unable to come to many scientifically rigorous conclusions. These fishes are generally too valuable to tag in large numbers and require special handling for successful tagging and release. Seasonal distribution provides some clues to migration and distribution, but data from commercial fleets are frequently incomplete.

The available data from the eastern Caribbean show seasonality for many species, but it is currently impossible to distinguish between directional migration and onshore-offshore movements. One feature is notable, most species are absent from the eastern Caribbean from July to September.

Yellowfin tuna

ICCAT espouses a two stock hypothesis for Atlantic yellowfin tuna, with discrete east and west Atlantic stocks separated at 30°W. Most analysis and information available in the ICCAT literature is for the eastern stock.

In the western Atlantic, an early analysis of Venezuelan fishing patterns showed that effort tended to shift from the Caribbean to the Atlantic during the fourth and first quarters. Migration of yellowfin tuna between the two fishing areas was postulated. A subsequent analysis has suggested that there may be separate Caribbean and West Atlantic Ocean stocks.

Most pertinent to the eastern Caribbean region is that interannual variation in catch rates from Barbados and the US Virgin Islands appear to correspond, suggesting they are from a common stock.

Skipjack tuna

Although there are studies and hypotheses concerning migration of skipjack in the Pacific, there are none for skipjack in the Atlantic. Movements of skipjack within, as well as into and out of, the eastern Caribbean are suggested by the seasonality in catches, but have not been studied. There is no specific information on stock structure of the eastern Caribbean skipjacks. ICCAT considers them part of a single western Atlantic skipjack stock, currently thought to be separate from another stock in the eastern Atlantic.

Bigeye tuna

ICCAT analyses are based on the hypothesis of a single Atlantic wide stock. Catches by Japanese longliners in the Atlantic during 1956-68 indicate that the greatest concentrations of bigeye tuna occurred in the eastern and southwestern Atlantic. Bigeye appear relatively scarce in the eastern Caribbean, being most common in October-November. This concurs with the present information on spawning. The greatest concentrations of spawning bigeye, inferred from larval distribution, are probably in the southern hemisphere (off the southeast coast of Brazil, mid- to southeast Atlantic and west coast of Africa) during the southern summer (October-March); and in the northern hemisphere (off the African coast and in the tropical mid- to eastern Atlantic) throughout the year.

Albacore

Most authors agree that there are two stocks (or subpopulations) of albacore in the Atlantic; a northern stock separated from a southern stock by latitude 5°N. However, there is uncertainty as to which stock the fish caught in the eastern Caribbean belong to. They are probably most closely associated with the north Atlantic stock.

Swordfish

Tagging indicates two or three stocks of swordfish in the Atlantic Ocean: (1) the northeastern Atlantic stock, with concentrations just off the Mediterranean Sea from September-December; (2) the northwestern Atlantic stock from Newfoundland to the Caribbean Sea; and (3) the southern Atlantic stock, with concentrations off Uruguay and Argentina from April-October.

Until recently, ICCAT has considered that swordfish caught in the eastern Caribbean are probably part of a Northwest Atlantic stock, but are now leaning toward an hypothesis of one large North Atlantic stock.

Sailfish

Tagging studies show that western Atlantic sailfish migrate between summer areas in the northern Gulf of Mexico and around Jacksonville-Cape Hatteras, and winter areas near southeastern Florida, through Cuba and the Virgin Islands, with recaptures as far south as Grenada and Guyana.

The seasonality of fisheries also indicates that Atlantic sailfish are most numerous in the Gulf of Mexico and western Caribbean during the summer and most numerous in the eastern Caribbean during the winter, with peaks in abundance during July and January, respectively.

Blue marlin

There appear to be two major concentrations of Atlantic blue marlin; one in the southwest Atlantic off the easternmost part of South America, and one in the northwest Atlantic in the Gulf of Mexico and Caribbean. It is unknown whether these two concentrations represent separate stocks or subpopulations or whether there is migration and intermixing between them. In the southwest Atlantic, blue marlin seem to be most abundant during the first two quarters of the year (January-June) whereas in the northwest Atlantic they are most abundant during the last three quarters (April-December).

White marlin

Tagging reveals that white marlin migrate between feeding, wintering and spawning areas along routes that may extend from Brazil to Canada. White marlin tagged at their summer feeding grounds in the Cape Hatteras-Cape Cod area have been recovered in late fall and winter off the northern coast of Colombia, Venezuela and the Guianas. The migratory routes of these fish are unknown but they may include both coastal and oceanic waters, as far east as longitude 40°W, where tagged fish have been recovered. The white marlin that aggregate off Venezuela have been found to move either south or north.

Fisheries

Yellowfin

In the eastern Caribbean, yellowfin tuna have been exploited mainly by longliners from Venezuela, Cuba, Japan, Korea, and Taiwan, and recently by purse seiners from Venezuela. The Caribbean islands exploit yellowfin as part of their multispecies fisheries using surface methods such as trolling and pole-and-line.

Exploratory trolling cruises conducted in 1969-71 caught too few yellowfin tuna to yield any indications of seasonality. Catch rates by Venezuelan longliners in 1960-65 tended to be lowest in the first quarter. Similarly, catch rates by Japanese longliners in 1956-68, indicated that yellowfin tuna were scarce in the Caribbean from January-March, but in April-September they increased in abundance toward the more northerly Leeward Islands and as far up as Cape Hatteras, USA. In contrast, the seasonality of the artisanal catch in the eastern Caribbean islands of Grenada, Saint Vincent, Barbados, Dominica and the US Virgin Islands show yellowfin to be most abundant in the first 4-6 months of the year.

Bigeye

In the Atlantic, bigeye catches are most often incidental to those of yellowfin, skipjack or albacore. They are taken by longlining or by live-bait, surface fishing with poles or handlines.

The numbers of bigeye caught in the eastern Caribbean are difficult to determine since catches are low and records are scarce. Bigeye are occasionally taken by artisanal fisheries of the Caribbean islands and by Japanese, Brazilian and Venezuelan commercial fisheries. There are no data on the numbers of bigeye caught in the eastern Caribbean by Venezuelan, Japanese or Brazilian vessels.

Albacore

In the Atlantic the three most important fisheries for albacore are: (1) Spanish and French operations in the Bay of Biscay and West European Basin; (2) seasonal pole-and-line fisheries of France, Spain and Portugal in the Bay of Biscay, and off Portugal and Morocco; and (3) summer and winter longline fisheries throughout the northern and southern hemispheres. The latter were traditionally Japanese but since the 1970s have included vessels from Korea, Taiwan, Brazil, Cuba, and Venezuela.

There are few records of albacore catches in the eastern Caribbean. However, albacore are most common around the Leeward Islands during April-August. The Japanese longline fishery (1956-68) caught most albacore in this region from April-June. Albacore are caught occasionally by the artisanal fisheries of the Caribbean islands.

Skipjack tuna

Skipjack tuna are currently exploited world-wide by: surface fisheries (mainly purse-seine, troll, and pole-and-line), for skipjack alone or together with other species; by longlining at 150-425 ft, primarily for yellowfin, bigeye, and bluefin tunas; and by longlining 100-200 ft, primarily for albacore.

The seasonality in Japanese longline catch and the results of tagging suggest that adult skipjack are most abundant in the eastern Caribbean during January-March when they are distributed from Puerto Rico along the Mona Passage to Dominica, east of the Lesser Antilles from Guadeloupe to Grenada, and east and northeast of Trinidad. Catches of skipjack in Grenada are sharply seasonal with a March-May peak, whereas in Martinique and Saint Vincent there are no easily discernible seasonal patterns. Exploratory trolling caught very few skipjack tuna in the Lesser Antilles.

Most longliners in the eastern Caribbean take skipjack as by-catch. Purse seiners, and pole-and-line baitboats which account for two-thirds of the western Atlantic catch, originate from Cuba, Venezuela and Brazil. During the period 1978-82 the Cuban skipjack catch remained at about 1 500 t/year, whereas that of Venezuela and Brazil increased from less than 500 t to over 12 000 t. In comparison the skipjack catches of Dominica and Saint Lucia, using handlines, trolling and seine-netting, remained around 80 and 100 t/year during the period 1976-82. Barbados reported catches of 78 and 72 t for 1981 and 1982 respectively.

Swordfish

Until recent years, Canada and the USA have been the main harvesters of swordfish in the waters off eastern North America. In the Caribbean, swordfish are rarely reported as recreational or artisanal catch, probably because most fisheries operate during the day when swordfish are unavailable at the surface.

Between 1981 and 1986, landings of US swordfish longliners fishing outside the US EEZ in the Caribbean have increased fourfold from about 500 t/year to about 2 000 t/year. At the same time, landings from the US EEZ decreased by half from about 4 000 t/year to about 2 000 t/year. A substantial proportion of this recent expansion has been into the eastern Caribbean, where US longliners range as far south as Saint Vincent and Grenada. Except for the British Virgin Islands, which has issued licences to several vessels, and for a few joint venture agreements, this fishing is unpermitted.

Sailfish

Atlantic-wide landings of sailfish increased steadily from 1974-84, with a similar but less marked trend for the western Atlantic. The artisanal fisheries of the Caribbean islands have caught sailfish for decades but separate records are few. ICCAT shows records for the Netherlands Antilles and Grenada for 1974-84, with annual catches of about 50 and 25 t respectively. In Barbados the billfish catch is probably comprised mainly of sailfish and blue marlin with lesser numbers of white marlin, swordfish and spearfish (Hunte, 1987).

Blue marlin

In the western central Atlantic (WECAF) region blue marlin are harvested principally by Japanese, Cuban, Venezuelan and Brazilian commercial longliners targeting tuna. Japan began longline fishing in the eastern Caribbean in 1958, Venezuela in 1960 and Cuba in 1963. From 1965-79, after the longline fishery had expanded to include the entire distributional range of the Atlantic blue marlin, there was a general decrease in the commercial catch of this species from the whole Atlantic. Total catches increased steadily to 2 600 t in 1982, then dropped to 1 600 t in 1983. These fluctuations are due mainly to the largest fishery, the Japanese.

The waters off continental America, the Gulf of Mexico and the Caribbean region have provided rich grounds for sport and artisanal fisheries for blue marlin. Important sportfishing centers for blue marlin are: close to La Guaira, Venezuela; Jamaica; Cuba; Puerto Rico, and the Virgin Islands. The recreational landings of blue marlin from the US Virgin Islands are highly seasonal, May to October, with a peak in July (Hunte, 1987).

Blue marlin are also exploited by the recreational and multispecies artisanal fisheries of the other Caribbean Islands. Trolling for marlin and sailfish took place in Montserrat, Saint Lucia, Barbados and Grenada before 1945. Significant catches by unclassified gears have been reported by FAO for Barbados (1976-79) and for Grenada (1977-79). Catch data from the Caribbean Islands do not generally distinguish between blue marlin, other marlins and sailfish. Barbados harvests billfish throughout the year, with peak catches in January and July.

White marlin

White marlin apparently do not migrate close to the islands of the Lesser Antilles. This may account for its infrequent mention in reports of eastern Caribbean island fisheries, although in most islands it is probably reported as billfish along with blue marlin and sailfish catches.

Current management

There are no regulations controlling the harvest of large pelagics in the eastern Caribbean. Since 1980, ICCAT has adopted a minimum size of 3.2 kg for yellowfin and bigeye tuna in an effort to reduce catches of juvenile tunas in the east Atlantic stock. There is not enough data on size composition of the catch to determine if a similar problem exists in the western Atlantic. There are no other ICCAT regulations for species currently harvested in the Lesser Antilles.

Population biology

Yellowfin

Yellowfin tuna are found throughout tropical and subtropical seas including the Atlantic, Pacific, and Indian Oceans. They are epipelagic and oceanic, above and below the thermocline. Vertical distribution appears to be influenced by the thermal structure of the water column, as is shown by the close correlation between the vulnerability of the fish to purse seine capture, the depth of the mixed layer, and the strength of the temperature gradient within the thermocline. Yellowfin tuna are essentially confined to the upper 100 m of the water column in areas with marked oxyclines. Schooling is common in near-surface waters, primarily by size, either in monospecific or multispecies groups.

Fork lengths of adult tuna taken from the northeastern Caribbean range from about 100-170 cm. Sexual maturity is usually attained at a FL exceeding 120 cm. Mature yellowfin tuna weigh about 48 kg but have been recorded at weights exceeding 100 kg.

Bigeye tuna

Bigeye occur worldwide in tropical and subtropical waters. They are epipelagic, occurring from the surface to depths of 400 m. Abundance of bigeye is mainly related to thermoclines.

At first spawning, bigeye are approximately 3 years of age and about 95 cm fork length. Little is known about the juveniles. Adults commonly reach an age of 6 to 8 years, with lengths exceeding 150 cm and weights exceeding 91 kg.

Skipjack tuna

Skipjack tuna are epipelagic, cosmopolitan inhabitants of tropical and subtropical waters warmer than about 15°C. Like yellowfin tuna, skipjacks occur in the Atlantic, Pacific, and Indian Oceans. They comprise about 40% of the world tuna catch, replacing yellowfin as the dominant tuna caught in the 1980s.

Skipjack tuna appear to aggregate at convergences, boundaries between cold and warm water masses, upwelling and other frontal features. Skipjacks occur from the surface to about 260 m during the day, and near the surface at night. The average length and length at maturity are about 50 cm and 45 cm, respectively.

The abundance of skipjack larvae and adults is markedly seasonal in the Atlantic. The post-larvae to one-year-olds are poorly known, as for most tunas in most areas. The larvae are most abundant in the Atlantic during November-April and are diffusely distributed from the Caribbean Sea to the Gulf of Guinea. In the Caribbean they are most abundant in the west from Venezuela to Cuba during January-March. In the eastern Caribbean skipjack with ripe gonads have been found in March-June and September-October and larvae are common in summer and in October-December.

Albacore

Albacore occur in all tropical and temperate oceans, including the Mediterranean, but are scarce in equatorial waters. Their depth distribution ranges from the surface down to at least 380 m in the Pacific and about 600 m in the Atlantic, and is thought to be determined by vertical thermal structures and oxygen contents. Most albacore occur in surface waters of 15.6-19.4°C. The large deep-swimming albacore occur in waters ranging from 13.5-25.2°C.

Albacore (maximum FL, 127 cm) are intermediate in size between the small tuna such as skipjack and large tuna such as yellowfin and bluefin. In the Atlantic, both sexes mature at a FL of about 94 cm. Males up to 109 cm and females up to 106 cm are not uncommon.

Swordfish

Swordfish are found in the tropical and temperate waters of the Pacific, Indian and Atlantic Oceans. In the Atlantic the limits of distribution are between 45°N and 40°-45°S. Vertical distribution ranges from the surface to a depth of 650 m. In shallow water, large swordfish may make feeding excursions to the bottom where the temperature is as low as 5-10°C. However, most swordfish seem to feed on surface and midwater organisms, primarily at night.

Age and growth have been difficult to determine since scales are absent in adults, otoliths are tiny, and the growth rings of bony parts are hard to interpret. However, scanning electron microscopy of otoliths suggests a maximum age of at least 14 years in males and 32 years in females. Females appear to grow more rapidly than males, achieving weights of 4, 15, 40, 70 and 110 kg at ages 1-5. Males mature at a smaller size (about 21 kg) than females (74 kg).

Larval distribution suggests that major spawning areas are in the Straits of Yucatan and Straits of Florida. Swordfish larvae are also common in the Lesser Antilles, indicating that spawning occurs there. Larvae are present throughout the year although peaks occur in February and November. Spawning aggregations of adult swordfish have not been reported in any area. Adults appear to be solitary, as there are no published reports of schooling.

Atlantic sailfish

Sailfish are epipelagic and widely distributed throughout the Atlantic between about latitude 40°N and 35°-40°S from New York to Brazil in the west, and off the African coast in the east. Although large aggregations of sailfish have been observed off Sierra Leone and Guinea, Senegal and in the Gulf of Guinea, concentrations seem most dense close to land masses in the western Atlantic, where they are particularly abundant in the Gulf of Mexico, the Caribbean, and around the easternmost tip of Brazil.

Little is known about the life history of sailfishes since young billfishes (Istiophoridae) are very similar and difficult to identify. Females appear to grow faster and larger than males. The recapture of a tagged sailfish, at liberty for 12 years, indicates that the prospective lifespan is 15 or 16 years.

Blue marlin

The distribution of blue marlin is mostly tropical. It is epipelagic and though largely oceanic, may frequent coastal areas. They are thought to range from near the surface to 150 m during feeding, and to exceed depths of 150 m when not feeding. They are usually solitary.

Blue marlin from the northeastern Caribbean mature at body weights exceeding 32 kg for males and 46 kg for females. Spawning in the northwestern Atlantic occurs from April to November. Protracted or multiple spawning has been indicated for blue marlin caught off Puerto Rico and the Virgin Islands. Peak spawning is thought to occur far offshore during July and August. Larvae and juveniles probably develop offshore since only a few of these early life-history stages have been collected close to shore at Jamaica, the Bahamas and off Florida.

White marlin

The white marlin is distributed over most of the Atlantic Ocean from latitude 35°S to 45°N. In each of the hemispheres distribution varies seasonally, reaching the highest latitudes only during the local warm seasons. This species is usually found in deep blue water over 100 m in depth.

Other determinants of distribution include bottom topography, salinity, planktonic abundance and currents. Steep drop-offs, submarine canyons and shoals, when located in areas of suitable water conditions, are often the site of feeding concentrations of white marlin.

White marlin are abundant along the US coast from Florida to Cape Cod, in the northern Gulf of Mexico, and the northwestern Caribbean but seem to be relatively scarce in the eastern Caribbean except in an area close to La Guaira, Venezuela. Analyses of Japanese longline data for 1956-68 indicate that white marlin are present in most areas of the eastern Caribbean from October to June but published reports of catches by the fisheries of the eastern Caribbean Islands are few. They are absent or rare around Puerto Rico during August and September.

The one major aggregation of white marlin in the southeastern Caribbean occurs during October to March off the coast of Venezuela. This aggregation, like similarly sized aggregations in the Gulf of Mexico and Cape Hatteras-Cape Cod area, is believed to be for feeding.

Assessment and management

Directions

There are so many unanswered questions regarding migration patterns and stock structure of these species that it would be pointless for eastern Caribbean countries to consider any stock assessment based on estimates of stock size. Where data are available, these types of analyses are currently carried out by ICCAT and for the Caribbean Fishery Management Council by the US National Marine Fisheries Service. At this stage, the most important activity is establishment of data collection systems in the region. The data from these can be used to monitor trends in abundance and to define migration patterns and stock boundaries.

In addition, size data from the fisheries coupled with basic biological information on growth and maturity schedules would contribute to ICCAT's evaluation of the potential danger of growth and/or recruitment overfishing. Depending on the available expertise and resources, it would be feasible to consider further analyses such as yield/recruit. However, it is much less feasible to attempt to control the size structure of the catch in these fisheries than in trawl, trap and seine fisheries, where mesh size can be regulated.

The most productive use of regional time and expertise for these wide ranging large pelagic species would be to become involved in ICCAT and CFMC assessment activities. This would be best achieved through regular attendance of one or two individuals (preferably the same ones each time) at ICCAT, and if possible at CFMC meetings. These individuals would thus become familiar with the techniques being used to assess these resources, and could provide feedback to the region as to the status of the resources. In addition, these participants would become familiar with the available data, and could begin to utilize them to answer questions relevant to the eastern Caribbean. For example, a closer look at Japanese, and US longline catch rate data from the adjacent ocean areas might indicate patterns relevant to the islands.

Potential yield

Until the ICCAT databases become adequate for general production or sequential population analysis, estimates of potential yield can only be of the roughest type, based on observed yields from intensely fished ocean and coastal habitats in other tropical regions. Marcille (1985) has attempted such an estimation procedure for two relevant areas: the southern Lesser Antilles, together with Trinidad and eastern Venezuela; and the northern Lesser Antilles including eastern Puerto Rico. These estimates, which are for oceanwide species such as yellowfin and skipjack tuna, are based on observed yields (per one degree square of ocean) of such species from other areas of the tropical Atlantic. A potential yield value of 660 t/year/degree square has been postulated for a rich intensely exploited oceanic zone, with a minimum of 100 t/year/degree square. The larger value was applied to the southern Lesser Antilles/Trinidad/Venezuela, whereas the lower value was considered appropriate for the northern Lesser Antilles/Puerto Rico zone. In each zone, squares with coastal influences were assumed to have a potential yield of 1 200 t/year, a value approximating the coastal zone of Senegal.

The potential yield estimates for the northern and southern zones were about 14 000 t/year and 20 000 t/year respectively. These estimates could be recalculated to apply to the EEZs of the Lesser Antilles, and together with estimates of fishing capacity, would give a first approximation of a target fleet size for development purposes. There are several reasons why these estimates may be inappropriate. For example oceanic productivity off west Africa is enhanced by upwelling, and there are no major areas of upwelling in this region. This may be partly compensated by the nutrient output of the big South American Rivers, but the extent to which this occurs, and how far into the Lesser Antilles any such influence extends, is unknown. It certainly seems unlikely that coastal influences of the northern Lesser Antillean islands, with minimal runoff, can be of similar magnitude to those off West Africa. Thus the figure of 1 200 t/year/degree square may be too high.

Marcille's (1985) warnings about these estimates should be taken very seriously. He notes that these yields can only be achieved at very high fishing effort, when catch per unit effort is relatively low. He advised that the target yield be set at 75% of his estimates, and that catch rates be monitored very closely as fishing effort increases.

Stock assessment

Assessment activities carried out by ICCAT are summarized below for some of the major species.

Yellowfin tuna

Due to the lack of a reliable abundance index, ICCAT is unable to draw any conclusions as to the status of the west Atlantic stock. There have been surplus production analyses for the entire Atlantic, but most of the data come from the eastern Atlantic.

More detailed analyses have been carried out in the eastern Atlantic, including virtual population analysis, and yield/recruit analysis. However, ICCAT suggests that these be interpreted cautiously, owing to unreliable catch data.

Bigeye tuna

The number of bigeye caught each year, by both Japanese and Brazilian longliners, has increased steadily since 1976. However, in the late 1970s and early 1980s, after the fisheries had expanded to include the whole range of bigeye distribution, and the fishing intensity on juveniles increased, CPUE for Japanese longliners fishing the whole Atlantic gradually decreased to about 60-65% of that in the early 1960s. In recent years, most of the bigeye taken were 4-5 years of age. Minimum size regulations (3.2 kg), aimed at increasing yield/recruit, have been in effect for bigeye since 1980, but do not appear to be having an effect.

Surplus production analysis for bigeye tuna gave an MSY range of 70 000-155 000 t depending on the natural mortality input, with the lower end being considered more realistic. Current catches are in the vicinity of 75 000 t.

Albacore

There are no specific data on abundance or catch trends in the eastern Caribbean. Those for the entire North Atlantic show a decrease between 1967-71 after which the abundance of these fish has stabilized. Despite apparent declining recruitment, ICCAT considers the stock to be in good condition.

Skipjack tuna

WECAF has stated that artisanal fishermen should increase their share of the overall catch of skipjack tuna, but that with no information on potential yields, it would be imprudent to extend into major commercial fisheries. To date, no CPUE data are available for the Caribbean area, including the Venezuelan fishery. However, in 1985, catches in the western Atlantic were up by about 50% over 1984.

Most islands currently record skipjack together with other species such as blackfin tuna and Sarda sarda, but Grenada and Martinique record skipjack separately (Hunte, 1987).

Swordfish

Owing to the value of the fishery and its recent expansion into the Caribbean, assessment of the status of the North Atlantic swordfish stock has been the subject of considerable recent activity. The most notable trend in the fishery has been the decline in mean weight of fish in the catch. This trend has been evident both within the US EEZ and in the Caribbean region, although weights in the latter area have been consistently 30-50% higher than those in the US EEZ.

Catch rate analyses on four size-based market categories show a marked decline in availability among the larger size classes, and indicate possible increases in availability of the two smaller-size categories in the last two years. Although this may indicate good recruitment in recent years, there is no reason to expect sustained production of good year classes, particularly in the face of declining mature biomass in the entire stock.

The recommendation of the recent assessments is that exploitation of small, immature fish should be prevented. One way of achieving this would be to close areas and seasons where high proportions of small fish were caught. The patterns of catch by size indicate that it would be possible to implement this strategy. Minimum size regulations would probably be ineffectual owing to mortality of released fish. The approaches of setting TACs or limiting total effort would depend on good estimates of fishing mortality for the entire stock, and the means of estimating the proportion of the catch which would be expected from a particular EEZ.

Sailfish

ICCAT considers West Atlantic sailfish to be only moderately exploited. This is based on a 1983 yield/recruit analysis which suggested that fishing mortality was about 20% below $F_{0.1}$. Confirmation of this conclusion by virtual population or production analysis is not possible owing to deficiencies in the data.

Blue marlin

Catches of blue marlin during the early 1970s are considered to have been near the maximum sustainable yield. This view is supported by the gradual decrease in Japanese longline CPUE during the 1970s, and the fact that it remains well below that of the late 1960s. Although the status of the stock is uncertain, and recent effort may have been below that required for MSY, continued low catch rates, and the recent increase in longline fishing effort in the Caribbean where blue marlin are known to occur, give cause for caution.

White marlin

White marlin catches show a slow, steady decline from 1974 to the present. Although, ICCAT remains uncertain of the status of this resource, there is probably little potential for increased yield.

MANAGEMENT OPTIONS FOR LARGE PELAGICS WITH STOCKS CONTAINED WITHIN THE LESSER ANTILLES REGION

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MANAGEMENT PLAN FOR REGIONAL LARGE PELAGICS

Introduction

Offshore pelagic resources are generally considered to hold the greatest potential for development, and most islands are attempting to increase their effort in these fisheries. The catch consists of several species with a wide variety of life histories: tunas, billfishes, dolphin, wahoo, kingfish, sharks. These fishes are usually exploited on the same fishing trips, often together with flyingfish, by boats ranging from canoes with outboard engines (Saint Lucia, Dominica) to larger inboard powered launches with ice containers (Barbados). Although the composition of the catch varies from island to island, dolphin, yellowfin tuna and wahoo are the most important large pelagics.

Although they comprise a single fishery in most places, these fishes vary widely in distribution, migratory patterns and in their potential for development. Following the conclusions reached in the Expert Consultation on Shared Fishery Resources of the Lesser Antilles, these species are considered in two groups: those for which stocks are probably contained within the Lesser Antilles region (for example dolphinfish, kingfish, wahoo, blackfin tuna); and

those for which stocks extend throughout the Atlantic, or at least the western Atlantic (for example, yellowfin tuna, skipjack tuna, billfishes and swordfish). The former group is considered in this plan.

Management objectives

The overall objective could be to maximize the catch of these species by fishermen of the region, and to reduce the proportion taken by unpermitted fishing, while ensuring that the stocks are not overfished. The objective should state whether the intention is to retain most of the catch for small-scale fishermen, to encourage commercial operations, or to conserve the resources to attract tourists interested in recreational fishing. If pursued together, these objectives may result in conflicts among the users.

Problems for resolution

Policy is needed regarding the preferred direction for development of fishing capacity for these species: large-scale commercial, enhanced small-scale, tourist/recreational or some combination of these.

Unpermitted fishing by foreign vessels, primarily longliners, continues to be a major problem. Establishment of an effective management plan will require that illegal fishing be brought under control.

Data on catches, and fishing effort are needed in order to determine the value of the fishery, and to evaluate changes which take place as fishing effort increases. The lack of these data also makes it impossible to carry out even preliminary analyses on seasonality and size composition of the catch, which may be important in assessing the status and structure of the stocks in the region.

Management unit

For the species considered in this plan (dolphinfish, blackfin tuna, little tunny, wahoo, Scomberomorus spp.), the waters of Lesser Antillean islands are considered to be the minimum management unit. Since this is based on limited information, the possibility that the stocks of these species extend outside the EEZs of the region should be actively investigated.

Current regulations

There are no regulations controlling the harvest of large offshore pelagic fishes in the Lesser Antilles.

Management options

For large pelagic species with stocks contained within the Lesser Antilles region, management measures implemented by Eastern Caribbean countries could be expected to have a significant impact on the status of the resource. However, these regional species are harvested along with the other large pelagics with wider ranging stocks, and are therefore also likely to be affected by fishing activities of distant water longline and purse seine vessels.

The options discussed here are presented under the assumption that current efforts to control unpermitted foreign fishing will continue, and will eventually minimize these activities in the waters of the Lesser Antilles.

Since these resources are regional and shared, all management options are considered at the regional level.

1. No action

Under this option, individual islands will continue to develop their small-scale fisheries, and to add larger vessels to their fleets. This will occur without reference to the shared nature of the resource, or development trends in the region. If these stocks are contained within the region, and if estimated potential yields (Marcille, 1985) are the correct order of magnitude, overcapitalization and overexploitation will probably occur within a decade.

2. Size/gear limits, closed seasons

At this time there is very little information on which to base such regulations. There are no indications of either growth or recruitment overfishing. Owing to the multispecies nature of the fishery, closed seasons for individual species will probably be inappropriate.

3. Total allowable catch (TAC)

In theory, TAC is the most direct way of limiting the amount of catch to the levels considered appropriate for the stocks. Apart from the problems of estimating the TAC, this approach will be virtually impossible for these multispecies fisheries, unless most or all of the catch is taken by large commercial vessels. Since TACs do not prevent overcapitalization, excess fishing capacity in the larger vessels could lead to closure of the fishery part way through the year, resulting in economic hardship for small-scale fishermen in coastal communities, and possibly to curtailment of sport fishing activities. Attempts to balance these various fishery components will lead to very complicated management systems with resulting high costs.

Unless simple methods based on past catches are employed, estimation of separate TACs for each of the species would be technically very complex, and costly, particularly if they are to be revised each year to take advantage of variations in abundance. Enforcement of separate TACs would be even more difficult, as regional catches would have to be compiled in real time, and the landing of each species prohibited as the TAC was reached.

4. Limited entry

A less complex, but also less precise, approach to regional management would be to limit the fleet to the size required to take the average potential yield. This fleet could be divided among participants in the fishery: namely various fleet components and various islands. This would appear to be the most feasible, reasonably simple, inexpensive, easily administered, method of joint management of shared resources.

This approach nonetheless requires some estimate of the long term average potential yield, and of the fleet required to catch it each year. Since there are several different vessel types involved in the pelagic fishery, it will be necessary to estimate their fishing power equivalency, for example, the number of canoes which equals a 15 m launch with 5 mi of longline. Effort could be allocated among islands in the lowest units (canoes?) and each island could then decide how to apportion its effort allocation among fleet components.

The oceanwide large pelagics and those considered in this plan are caught by the vessels on the same trips, and there could be substantial discrepancies between the fleet requirements for the two categories. The effects of trade-offs will have to be evaluated and compromises considered.

Very crude estimates of potential yield, such as by Marcille (1985), could be used at first, and adjusted as further information becomes available.

Habitat conservation

There are no well documented habitat conservation considerations for these species. However, recent events relating to possible offshore dumping of toxic wastes in the Caribbean give cause for concern and vigilance.

Regional implications

The options above require that there be a regional organization to coordinate data collection and compilation, such as currently exists for the OECS, and to establish estimates of potential yield. A forum will be required for discussion of allocation and estimates of vessel equivalency. Some regional technical group, either government or university based, would have to be responsible for the analysis and interpretation of data at the regional level.

Action summary

Short term (1-3 years)

Islands should decide on a development policy for offshore pelagics: commercial, small-scale, recreational, or a combination thereof, including means of resolving potential conflicts.

Monitoring systems for catch and effort data as well as for length frequency samples should be established immediately. This will provide: data on total catch, estimates of the equivalency of various fishing units, and baseline information against which to evaluate the impacts of increased exploitation.

The current rough estimates of potential yield should be reviewed and revised using all available data from tropical pelagic fisheries. This estimate should include upper and lower limits. The scope for expansion should be set as the difference between the current catch and the most reasonable estimate of potential yield. Safety margins should be considered.

Medium term (3-5 years)

Representatives from regional institutions should be designated to participate in ICCAT activities. This would facilitate the exchange of information between ICCAT and the region, and develop an appreciation of the issues relating to assessment and management of these species.

The scope for expansion should be allocated among islands according to agreed principles. This allocation could take the form of a nonbinding agreement in the first instance. This will give islands an indication of the extent of fleet expansion that would be reasonable.

First estimates of vessel equivalency should be agreed upon among islands.

Long term (5-10 years)

Analysis of catch data for migratory patterns and effects of increased exploitation. Revision of estimates of potential yield and vessel equivalency.

SUPPORTING MATERIAL FOR REGIONAL LARGE PELAGICS

Unless otherwise referenced, the information presented below is summarized from papers in the Report and Proceedings of the Expert Consultation on Shared Fishery Resources of the Lesser Antilles (Mahon, 1987; Hunte, 1987; Mahon and Mahon, 1987), and from the background document to the CFMC FMP (Centaur Associates, 1983). Detailed information is provided for the major species only.

Species composition

The most important species to be contained within the region are: dolphinfish, blackfin tuna, little tunny, Scomberomorus spp. (king and cero mackerel). Of lesser importance are bonito, and carangids such as amberjacks, rainbow runner, and blue runner.

Stock structure

Evidence for the assumption that stocks of the species considered in this plan are localized in the Lesser Antilles, and probably range throughout these waters, is largely circumstantial. Species which are generally coastal in habitat are considered more likely to display the above pattern. However, there is little evidence to suggest that in the south, the Grenada passage, or in the north, the Anegada or Mona passages are particularly likely barriers to migration/dispersal of these species. The main point is that these are the pelagic species for which regional management is most likely to have an effect.

The available information for the main species is summarized below.

Dolphinfish

Dolphin are distributed worldwide in tropical and subtropical waters. In the western Atlantic, dolphin are reported from, Canada, to Rio de Janeiro, Brazil, but are most abundant in the Gulf of Mexico, in the Florida current, off Central America, Puerto Rico and throughout the Caribbean Sea.

Preliminary analysis of seasonal catch per unit effort, and size frequency data suggest that there is one stock of dolphin in the eastern Caribbean region. Comparisons of various population parameters, and seasonality suggest that this stock may be separate from that off the eastern USA. However, the location of the division between the stocks is unclear, as are the factors which might be responsible for their separation. It is possible that the differences observed result from point sampling on a gradient.

Scomberomorus

Studies of Scomberomorus spp. in the eastern USA and Gulf of Mexico show regular seasonal migrations. These follow the coast and are confined to the continental shelf. This suggests that Scomberomorus spp. in the eastern Caribbean might migrate along the island chain. Indeed these species are

usually caught on or near island shelves. The extent to which channels between islands might restrict movement is unknown, but given the size and swimming ability of these species, it is unlikely to be great.

Puerto Rican fishermen and biologists believe there is a westward migration along the edge of the shelf off Puerto Rico from November to April, and that king mackerel apparently leave the Virgin Islands during November, arriving off the east coast of Puerto Rico in November and off the west coast several weeks later (Centaur Associates, 1983). These migrants may remain around Puerto Rico to feed and spawn, since ripe fish of both sexes are found there from May to August. Peak spawning is believed to occur during June and August.

Spawning and feeding migrations have also been hypothesized for king mackerel around Trinidad. There is no further information regarding migration of king mackerel in the Caribbean region. Although they are caught at different times of the year in different islands, no trend is apparent in the reported peaks in catch. The lack of patterns in seasonality of kingfish in the eastern Caribbean may be due to recording of Scomberomorus and wahoo together as kingfish. King mackerel may be year-round residents in the coastal waters of each island or may undergo (as yet unreported) small-scale movements between islands.

Nothing has been published on the stock structure of king mackerel in the eastern Caribbean. A comparison of fish from areas in the USA, West Indies and Brazil found a few significant differences in morphometrics, but none in meristics, suggesting that king mackerel from the western Atlantic region belong to a single population. There is no information on migration or stock structure of cero mackerel, and little on its specific distribution.

Wahoo

There is little available information on migration, and stock structure of wahoo in the western central Atlantic. This species is reportedly, common off northern Brazil, in the Gulf of Mexico, in the Gulf Stream from Florida to Cape Hatteras and in the Caribbean. It also appears to be migratory in the Florida Straits and Gulf Stream.

As more information is acquired, the appropriate management unit for this species may turn out to be larger than the Lesser Antilles.

Blackfin tuna

In the Caribbean blackfin tuna seem to be most abundant off Cuba, the northern Lesser Antilles, and along the east coast of Puerto Rico. Sightings and exploratory catches of blackfin tuna are seasonal. Most blackfin seem to occur during April-August around the Leeward Islands. In contrast, recreational catch rates from the US Virgin Islands are relatively low in July and August. However, this may result from targeting marlin during these months. Catches in the Windward Islands were too small to provide any information on seasonality.

Stock structure is unknown. ICCAT barely mentions blackfin tuna in the group 'small tuna', and stresses the need for special efforts to record and report the catches of these and other small tunas. Owing to its tendency to be associated with, and to migrate along island shelves, the Lesser Antilles should be considered to be the minimum management unit for this species.

Little tunny

Off the eastern USA the seasonality of fisheries suggests a southward migration of little tunny during the fall and winter. Fishermen and biologists suggest that they migrate east-west along the outer edge of the island shelf (drop-off) from the Virgin Islands past Puerto Rico to the Dominican Republic, and back (Centaur Associates, 1983). Trolling explorations in the Leeward Islands caught most little tunny during March-May. Off Dominica, the reported fishing season was from August-September, whereas in Saint Lucia and Grenada, the season extended from October-November and November-December, respectively. This staggering of seasons is consistent with the migration along the islands suggested by Centaur Associates (1983).

Probably because of their minor commercial importance, there are very few studies on the abundance and stock structure of these fish. The few that have been conducted have focused on little tunny in the Mediterranean and eastern Atlantic and have proposed the existence of different stocks. ICCAT recommends research on the characteristics of little tunny in the western Atlantic.

Fisheries

Dolphinfish

Dolphin are probably the most important large pelagic species caught by the fisheries of the Lesser Antilles. They are taken primarily by trolling, and more recently by longlining. Dolphin are not targeted by any of the foreign fleets, but are a frequent bycatch in longlining for tuna.

Scomberomorus and wahoo

'Kingfish' are a significant part of the catch of large pelagic fishes from the eastern Caribbean region. The major problem is that both Scomberomorus spp. and wahoo are recorded in this category. Therefore, it is impossible to evaluate the relative contribution of these species at the regional level, or to examine their seasonality. In a few places, studies indicate that most of the 'kingfish' catch is wahoo. In Barbados, wahoo comprise about 3.4% (74 t) of the total landings of pelagics, compared to 14.4% (148 t) for Saint Lucia.

There is no mention of S. regalis, cero mackerel, as a component of the catch in any islands except the US Virgin Islands and Martinique. It was a regular but not abundant component of the catch in exploratory trolling in the late 1960s and early 1970s. This species should be common in the eastern Caribbean, and as mentioned above is almost certainly recorded as kingfish.

There are no large-scale fisheries directed at wahoo in the western Atlantic, although it is a prized catch of artisanal and game fishermen. Wahoo are fished year round throughout the eastern Caribbean, but catches are highest during the first half of the year, usually in May, and are especially low during June, July and August. This may reflect a reduction in effort due to the absence of other large pelagics, or may indicate that wahoo are less available at this time.

Blackfin tuna

Brazil and Cuba are currently the primary commercial exploiters of blackfin tuna. In the 1950s, when the harvesting of blackfin became a year-round operation, the Cubans caught blackfin and skipjack tuna with poles and

handlines using live bait. These two species were marketed together as "bonito en aceite". From 1962 to the present, the pole-and-line catch has been supplemented by purse seining.

Trolling has been explored by the USA as a method for supporting an independent fishery for surface pelagics, including blackfin. These explorations suggest that large-scale trolling operations for blackfin alone would meet with little success. However, blackfin tuna are sufficiently abundant in the eastern Caribbean to support artisanal fisheries. Blackfin have traditionally been exploited by most of the Caribbean islands.

Little tunny

The little tunny has traditionally been of minor commercial value compared to Thunnus spp. However, little tunny are relatively abundant in the Atlantic and Mediterranean and are fished by about 18 countries including Venezuela, Ghana, Côte d'Ivoire, Mauritania, Spain and Angola. The largest catches in the Atlantic were reported during 1975-81 by Venezuela in the WECAF region.

In the eastern Caribbean, little tunny are harvested regularly by multi-species artisanal fisheries using seines and trolling. Caribbean islands which have been reported to catch little tunny (or spotted bonito, as they are often called) are: Puerto Rico, the Virgin Islands, Martinique, Dominica, Saint Lucia, Grenada, Trinidad and Tobago. However, Hunte (1987) does not refer to this species, which suggests that it may be recorded as bonito or some other tuna.

Current management

There are no regulations currently controlling the harvesting of these species in the eastern Caribbean.

Population biology

Dolphinfish

This epipelagic predator is often found in association with drifting objects. Dolphin are primarily piscivorous, feeding on flyingfish and other small pelagics. Growth in dolphin is rapid and its lifespan is short, especially in the south of its range. Off North Carolina, dolphin reached a mean length of about 125 cm, at the maximum observed age of three years, whereas off Barbados, the maximum observed age and length were about 1 year and 110 cm respectively.

Dolphin have an extended spawning season and are probably multiple spawners. The timing and extent of the spawning season vary with the locality. Off Barbados, spawning appears to extend throughout most of the year.

Scomberomorus

King mackerel inhabit the tropical and subtropical western Atlantic from the Gulf of Maine to Rio de Janeiro, Brazil, including the Gulf of Mexico and Caribbean Sea. It is coastal, seldom found in low salinity estuaries or off the shelf. The king mackerel is the largest Scomberomorus, commonly up to 70 cm in FL. Males and females grow at similar rates until age 5, after which females grow faster. Adults mature between ages 4 and 6, and can live for at least 14 years.

Cero mackerel occurs in tropical and subtropical waters from Cape Cod to Rio de Janeiro, but is most abundant around reefs in southern Florida, the Bahamas and the Caribbean islands.

Wahoo

Wahoo inhabit the tropical and subtropical Atlantic, Pacific and Indian Oceans, including the Caribbean and Mediterranean Seas but is not abundant in any single area.

The life history of the wahoo is not well known. Adults commonly range between 100-170 cm. Wahoo of both sexes mature in their first year. Spawning occurs at about 85 cm in males, and about 100 cm in females. Larval and post-larval wahoo have been collected from May to October in the Straits of Yucatan and Florida, at depths exceeding 100 m. Growth during the first year is rapid, and the 5 year life-span of most wahoo is short compared to that of other mackerels (Centaur Associates, 1983).

Blackfin tuna

Blackfin is the only species of tuna restricted to the western Atlantic, where it is distributed from southern New England to Rio de Janeiro, throughout the Caribbean Sea and Gulf of Mexico. Blackfin tuna usually occur at or near the surface throughout the Gulf and Caribbean in large schools, either with conspecifics, or mixed with skipjack tuna. The average length of adult blackfin is about 55 cm. Most of the fish caught in the Caribbean are between 2 and 5 years of age.

Spawning times and localities, as well as the distribution of larvae and juveniles, are poorly known. It has been suggested that blackfin tuna spawn in the Lesser Antilles since small fish have been caught while trolling off Saint Pierre. Moreover, adult males and females with ripe gonads have been caught off Puerto Rico from September to December.

Little tunny

Little tunny is found along both shores of the Atlantic Ocean and in the Mediterranean Sea. In the western Atlantic it is common from Maine to the northern boundary of Brazil. Throughout its life little tunny seldom occurs more than a few hundred miles from land masses or island chains. It is epipelagic, schooling mostly at the surface with other individuals of similar size. In the western Atlantic, little tunny often occur with Atlantic bonitos (Sarda sarda) and frigate mackerels (Auxis thazard) in large aggregations.

The growth of little tunny in the western Atlantic has not been studied. Elsewhere, maturity is attained after about 2 years at a length of about 35 cm, and the fish commonly live to 4 years of age, growing to 75 cm or more.

The distributions of all life-stages of the little tunny are similar. Adults are predominantly coastal, frequently found in turbid inshore water influenced by river discharge. Spawning, as inferred from the presence of larvae and juveniles, is mostly along the American and African continental shelves. Off the coast of Florida and in the Gulf of Mexico, the spawning season extends from March to November. Near Puerto Rico and the Virgin Islands, there are indications of spawning around May-June. Spawning has not been reported around the other Caribbean islands.

Assessment and management

There are so many unanswered questions regarding migration patterns and stock structure of these species that it would probably be pointless to consider any stock assessment based on estimates of stock size.

Given the impending expansion of fisheries on these species, especially in the northern islands and the virtual absence of data on their potential yields, there should be a considerable emphasis on monitoring catch and catch per unit effort. With accurate seasonal catch and effort data over the next 5-10 years and accompanying information on sizes of fish caught, the region would acquire a picture of migration, distribution and the response of the resource to increased fishing pressure.

In the eastern Caribbean, significant time-series of catch rates exist only for the Virgin Islands and Barbados. These show substantial interannual variability in abundance/availability but do not reveal any trends.

Growth and recruitment overfishing

Acquisition of size data from the fisheries coupled with basic biological information on growth and maturity schedules would allow an evaluation of the potential danger of growth and/or recruitment over fishing. At first this could be done by simple methods such as comparing the size of fish in the catch to the size at maturity, and to the known maximum size. Depending on the available expertise and resources, it would be feasible to consider further analyses such as yield/recruit, or virtual population analysis.

With the possible exception of dolphinfish, there is no information regarding the relationships between stock and recruitment for any of these species, or on the effects of environmental parameters on recruitment. For dolphinfish, attempts to use the catch per unit effort time series from Barbados to look at stock recruitment relations are confounded by changes in fishing power through time, and by inadequate data on stock and population structure.

Potential yield

Without better information on stock structure, and catches, estimates of potential yield can only be of the roughest type, based on observed yields from intensely fished ocean and near island habitats in other tropical regions. Marcille (1985) has attempted such an estimation procedure for the Lesser Antilles by extrapolating catches in those islands with pelagic fisheries to those with none. On the basis of comparison with catch per unit shoreline in other parts of the Atlantic, he adjusts the total upwards slightly, with due consideration for low productivity due to nutrient limitation in the Lesser Antilles. He estimates a production potential of 6 000-7 000 t of small tunalike species, not including dolphin. This he compares to the 1985 reported catches of 2 000-4 000 t.

On the basis of these estimates one could envisage increases in landings of about 50-80% above 1985 levels in islands with pelagic fisheries, and expansion to similar levels in those islands which do not currently harvest pelagics. However, more detailed estimates of this type should be carried out to establish the likely range of potential yield which could be expected. Such estimates would involve substantial compilation of data from similar habitats in other parts of the world, and will in themselves require considerable investment in time.

MANAGEMENT OPTIONS FOR FLYINGFISH

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MANAGEMENT PLAN FOR FLYINGFISH

Introduction

Flyingfish (Hirundichthys affinis) are the most important component of the fisheries for pelagic species in the southeastern Caribbean (Mahon, Oxenford and Hunte, 1986). Total annual catch by all islands is estimated to be around 4 000-5 000 t, with a landed value of about US\$ 5.5 million. Barbados, the major participant in this fishery, has recently expanded its fleet, about doubling its catch. Other islands are developing their fisheries for pelagics in general, and for flyingfish in particular. The ability of the flyingfish stock in the eastern Caribbean to sustain increased exploitation is a matter of concern for all islands participating in the fishery.

Management objectives

The objective should be to maximize long-term catches of flyingfish while attempting to minimize economic uncertainty for the harvesters, and variability in supply to consumers, by promoting stability in catches from year to year.

Management should consider the possible impact of large removals of flyingfish on abundance of pelagic predators, e.g., dolphinfish, which are also exploited.

Problems for resolution

Data on catch, effort, and fishing patterns are needed throughout the range of the fishery.

Management unit

The minimum management unit for flyingfish should be the Lesser Antilles region.

Current regulations

There are no regulations currently in effect for flyingfish.

Management options and implications

1. No action

Given the rapid and successful expansion of the flyingfishing fleet in Barbados, and the stated aim of other Lesser Antillean islands to expand their flyingfish fisheries, overcapitalisation and overexploitation of this fishery appear inevitable if some means of controlling fishing effort is not devised.

2. Size and gear limitation

Owing to the small size of flyingfish, processing and marketing constraints will probably prevent growth overfishing. If the fishery did shift its effort toward the early part of the season, and catch progressively smaller fish, the size of fish in the catch could be controlled by regulating gillnet mesh size. However, as the fishing method depends on the aggregation of fish for spawning, it is unlikely that such a temporal shift could go back past the age of first maturity without the fishery undergoing a radical change.

Nevertheless, since spawning is extended over about 6-8 months, taking a large proportion of the catch early in the season could reduce reproductive potential to unsafe levels. In theory, gillnet mesh size regulation could effectively limit the fishery to a point in the annual cycle where the fish had matured and spawned. However recent results suggest that classical gillnet selectivity theory may not apply to flyingfish which are mainly caught by entanglement while trying to spawn on the net.

3. Closed seasons

For similar reasons to those discussed above, closed seasons could be used to control the size of fish in the catch, and to protect the reproductive potential of the stock. The season could open on a date (which could be fixed or variable) which would allow a certain amount of spawning to take place before exploitation begins.

4. Limited entry

Size/gear limits and closed seasons may or may not succeed in conserving the resource, but in either case would not protect against overcapitalization of the fishery. This can most readily be achieved by limiting fleet size directly. This will be less flexible than a TAC approach, which can track interannual variability in abundance. Assuming there is some estimate of an optimal long-term average catch, the appropriate fleet size can then be expressed in terms of the number of fishing units with the lowest fishing power (e.g., canoes). These units could then be allocated among participating islands. Intercalibration of the various vessels fishing flyingfish would allow the conversion of the allocation to the number of vessels of the type to be used in that island.

Estimating the amount of effort which would correspond to the optimum exploitation rate would require information on fishing mortality. Rough estimates of total catch and total stock size could give first approximations of fishing mortality. Even so, the fact that flyingfish are part of a multispecies pelagic fishery would make the estimation of the corresponding fishing effort rather imprecise. Depending on the availability of, and preference for, other species, the total effort directed at flyingfish could vary considerably from year to year. Variable effort would be expected to increase the probability of stock depletion and collapse.

5. Total allowable catch (TAC)

A TAC approach to managing flyingfish will probably be impractical, as it will require the ability to compile catches on a regional basis in real time and to close the fishery when the TAC has been taken. However, from the point of view of resource allocation, TACs have many advantages. The TAC can be divided among the participants (countries) in the fishery, which can then take their share in any way they see fit, that is, with any combination of vessel/gear.

Habitat conservation

There are no well documented habitat conservation considerations for these species. However, recent events relating to possible offshore dumping of toxic wastes in the Caribbean give cause for concern and vigilance.

Regional implications

Decisions on which management policy to adopt will have to consider the implications of implementation at the regional level. This will depend on whether it is the intention that each participating island should take its share in its own EEZ, or whether economic efficiency should be promoted by allowing all participants to fish in the areas of high abundance.

In the former case, allocation of fishing effort will be more difficult since spatial variability in abundance, and thus catch rates will have to be considered in allocating effort. If catch rates from areas of relatively high abundance are used in the effort allocation, an island with a large area of relatively low abundance may not be able to take its share of the resource with its effort allocation. If the fishing activities of each island are to be confined to its EEZ, then a catch allocation scheme may be appropriate.

Action summary

Short term (1-3 years)

Most short term activity will relate to the Eastern Caribbean Flyingfish Program (ECFP), for example, the establishment of monitoring systems for catch and effort data, and length frequency samples. The studies in progress include: tagging for migration and stock structure; surveys for distribution/abundance of early life-history stages; seasonal distribution, abundance and bionomics of adults and juveniles around Barbados; examination of fishing patterns and catch per unit effort as an index of abundance.

Participating countries should continue to develop a regional policy for the exploitation and management of flyingfish.

Medium-long term (3-10 years)

Future activities will largely be determined by the results of the ECFP.

SUPPORTING MATERIAL FOR FLYINGFISH

Fullest reviews of the biology of and fisheries for flyingfish are contained in the proceedings of two workshops (Mahon, Oxenford and Hunte, 1986; and Oxenford, Hunte and Mahon, 1988).

Species composition

The fourwing flyingfish (Hirundichthys affinis) is believed to contribute more than 95% of the catch in the Lesser Antilles. The guineaman (Cypselurus cyanopterus), a larger species frequently occurs in the catch. Most other species are too rare, or small to be commercially important.

Stock structure

Apart from general, broadscale distribution, the only other information on migration, distribution, and stock structure must be derived from fishery data. Three hypotheses have been suggested to explain the seasonal availability of H. affinis to the fisheries. The first is that there is a large-scale eastward spawning migration from the central Caribbean Sea, past the island arc, into the Atlantic Ocean. Given the strong easterly currents in the region, this migration would compensate for passive westward drift of eggs, larvae and juveniles. However, complex current patterns east of the Lesser Antilles arc may serve to retain these early life-history stages.

The second hypothesis is that there is no large-scale migration, but that the fish aggregate into schools during the spawning season thus becoming available to the fishing gear. The association of these fishes with flotsam on which they spawn supports this hypothesis.

The third hypothesis is that there is a high level of post-spawning mortality and that the period of apparent low abundance is an interval between the availability of generations to the fishery.

There is no information on whether H. affinis in the eastern Caribbean comprises one large stock or several local ones. The similarity between interannual patterns in catch rates in Barbados and Martinique might suggest a single stock but could also result from local stocks responding to environmental factors operating on a regional scale.

Fisheries

General status

H. affinis is an important component of the catch in the southeastern Caribbean islands from Dominica to Tobago, with the exception of Saint Vincent. There is also a fishery off the northeast coast of Brazil. The fish are captured with surface gillnets, handlines and dipnets after being lured near boats with tethered fish-attracting devices and chum. The average total annual catch in the eastern Caribbean (1979-84) was about 4 000 t, with an average annual value of about US\$ 4.5 million, and is now probably about 20% higher. The catch rates of H. affinis in the eastern Caribbean are sharply seasonal. The fishing season extends from October to July, with a major peak around May and indications of a minor peak around November. Although there are minor differences, the seasonal pattern is similar among islands. The fish are consistently unavailable to the fisheries in August and September.

Current management

There are no management regulations or policies relating to flyingfish.

Population biology

Growth

Growth rate and longevity are little known. Modal analysis indicates that flyingfish grow to about 20 cm during the first year. The maximum observed size (about 30 cm) suggests that this species does not live past 18 months. Work in progress indicates that there are daily growth rings in otoliths which can be used to estimate growth and longevity.

Reproduction

Flyingfish are surface-schooling, particularly during the spawning season when they frequently aggregate around floating objects on which they deposit their eggs. In the eastern Caribbean, H. affinis spawn from October to August but there is a peak from March through July.

Larval distribution and recruitment

Early life history stages have been described but little is known of their distribution.

Assessment and management

Growth overfishing and yield/recruit (Y/R)

If flyingfish are annual, the concept of maximizing yield/recruit by size limits would apply only over a one year period. In theory, the opening of the fishery could be delayed if it were found that the fishery were catching fish which were too small. Alternatively, the mesh size of the gillnets used could be regulated. In practice, assuming a high rate of mortality in this species, and given the small size of the fish, it is likely that processing and market constraints on fish size would come into play before growth overfishing could occur.

Recruitment overfishing

Preliminary analysis of the time series of catch and effort data from Barbados could not identify any relationship between stock and recruitment. The analysis assumed that CPUE was a valid index of abundance in any year, and that flyingfish are annual. Therefore, the CPUE in each year was taken as the recruitment produced by the stock indicated by the CPUE in the previous year.

There was considerable variability in recruitment which was unrelated to stock size. Preliminary analysis indicated that a significant proportion of this variability was related to large scale climatic/environmental parameters. Consequently, there is the potential to predict of recruitment, which could be useful depending on the management strategy adopted, e.g., TAC management.

Variable recruitment in an annual species could lead to rapid and unpredictable recruitment failure once a particular stock threshold is passed. There is therefore cause for concern regarding the steady increase in exploitation of this species.

Potential yield

Estimating potential yield for a small offshore pelagic species such as flyingfish will be very difficult. The approach of the ECFFP will be to first determine if there appear to be significant quantities of flyingfish outside the area currently fished, and to extrapolate from catches and exploitation rates inside the fished area to the entire area occupied by the stock (Oxenford, Hunte and Mahon, 1988). This approach, although very approximate, should provide a useful indication of the scope for expansion.

Simulation modelling

Three harvesting policies for flyingfish were evaluated using a stochastic population model based on a Ricker stock-recruitment relationship and the historically observed variability in recruitment (Mahon, 1988). A constant escapement policy results in a long term average catch which is about 10% greater than the optimum which could be obtained under a constant effort policy. With constant escapement, interannual variability in catch is higher, but the tendency for the stock to be reduced to and remain at critically low levels is less than with constant effort, buffered by the closure of the fishery at low stock levels. Owing to the variability in recruitment, the constant catch option does not appear to be appropriate for flyingfish. The information required for implementation of the policies is not yet available. The requirements for the constant effort policy are much less than those for the escapement approach, and the former may be most appropriate, especially if regional management will be attempted. The observed behaviour of the stock does not augur well for precision management, and in particular, indicates that a gradual development and monitoring approach would probably fail to locate the optimal effort before the stock collapsed.

MANAGEMENT OPTIONS FOR COASTAL PELAGICS

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MANAGEMENT PLAN FOR COASTAL PELAGICS

Introduction

This management plan addresses a variety of small pelagic fishes with various life-histories, e.g., small schooling clupeids, jacks, and ballahoo, as well as small tunas, and juveniles of larger tunas and tuna-like fishes. These are exploited primarily by beach seines, gillnets and cast nets.

The overall contribution of coastal pelagics to total landings in the Lesser Antilles is relatively small, but varies considerably among islands ranging from about 30% of the catch in Grenada to less than 1% in Barbados. These fishes are often used as bait in other fisheries, but their importance in this respect has not been documented. Several islands report that catches of coastal pelagics have declined in recent years. However, there is no documentation of the extent of the decline or the species involved. There is very little information on the distribution or migration of these species.

Management objectives

The objective would be to maximize catches of these species for small-scale fishermen in coastal communities, while ensuring that the stocks are not overexploited. Commercial size operations for coastal pelagics could be prohibited.

Problems for resolution

There is a need for data on catch, effort, species and size composition.

Management unit

Until there is better information on coastal pelagic species, the island shelf should probably be considered as the basic management unit. Where two or more States share a single shelf, joint management is indicated. However, many of these species appear to be seasonal, and there is the distinct possibility that adults of several may migrate between shelves. Finally, the possible interaction of shelf stocks through planktonic early life history stages should be considered. Owing to the possible effects of overfishing in one area on recruitment to fished stocks in a neighbouring area, local regulations may have regional implications.

Current regulations

Such regulations as are currently in place regulate net mesh size, and prohibit the hauling of a ballahoo net anywhere else but into a boat.

Management options and implications

The virtual lack of data on these fisheries precludes any serious management planning, and no short term conservation measures are warranted. Trends in these fisheries should be documented by the establishment of data collection systems which would acquire catch, effort, species composition and size data.

1. No action

It is possible that the objectives stated above will be achieved under the no action (except monitoring) option. There is a finite number of suitable places for setting beach seines which, together with the time required for a set, limits the total effort which can be deployed. As data become available it will be possible to assess whether this total effort is, or has been, sufficient to overexploit the resource. However, in some places, seines are set offshore in purse fashion. If this practice becomes more common the above constraint on total effort would not apply.

The introduction of even a few medium size vessels with large seines, which can follow schools of fish from bay to bay, could have serious impacts on small-scale fishermen.

2. Standard regulations (size limits, closed seasons, limited entry TAC)

Extensive discussion of these approaches to regulating seine fisheries for coastal pelagics is not warranted at this stage. It is first necessary to establish whether the resource is in need of conservation, or whether there is excess fishing effort.

If the analyses suggested here indicate that the catch is comprised of a large proportion of juveniles, or that there is growth overfishing, mesh size regulations would probably be appropriate. However, if the fishery is catching juveniles which move offshore as they grow and mature, then the benefits of larger mesh size will not be realized by the seine fishermen, only by the offshore fishermen.

3. Communal property rights

Of all fisheries in the Lesser Antilles, coastal seine fisheries probably hold the most potential for community based management. Seine boats are usually rowed or powered by small outboards, and therefore fish close to the home base. Further information on the practices and attitudes of fishermen will be required before the feasibility of this approach can be evaluated. Certain informal practices, e.g., in Grenada, are already used to minimize conflicts among fishermen wishing to fish on the same grounds.

Habitat conservation

Mangrove lagoons, estuaries and seagrass beds are nursery areas for the young of many of the species caught in these fisheries. Declining catches may reflect destruction and degradation of these habitats rather than over-exploitation. Efforts should be made to emphasise the significance of these habitats for coastal fisheries, and to represent the interests of these fisheries in coastal management/development planning.

Action summary

Short term (1-3 years)

Monitoring systems for catch, effort, species composition and size frequency samples should be established immediately. Emphasis should be on obtaining data on trends in abundance, seasonality and possible migration. However, size data could be used for assessment of the numbers of immature individuals being caught.

Fishing practices and the attitudes of fishermen to community based management should be explored.

Medium to long term (3-10 years)

Further action would be based on results of short term action above.

SUPPORTING MATERIAL FOR COASTAL PELAGICS

Unless otherwise referenced, the information presented below is summarized from papers in the Report and Proceedings of the Expert Consultation on Shared Fishery Resources of the Lesser Antilles (Mahon, 1987), and from the background document to the CFMC FMP (Centaur Associates, 1983).

Species composition

The species composition of catches of small coastal pelagics has only been reported from a few islands. The main species from seine catches are: ballyhoo (Hemiramphus spp.), small jacks (Caranx spp.), scads (Selar spp.), and robins or scads (Decapterus spp.). Small tunas, and the young of large tunas, such as yellowfin, may also be caught. The main species taken in small seines and cast nets are sardines, herrings, pilchards, anchovies, thread herrings and silversides (Clupeiformes, Atherinidae), known as fry, fray, and sprats.

Stock structure

There is virtually no information on stock structure, distribution, and migration of these species in the Lesser Antilles. Except for the juvenile tunas, it may be appropriate to initially assume that the stocks are at least island shelf specific. Nonetheless, as for other species with planktonic early life history stages, dispersal between islands is possible. The extent to which such dispersal may affect recruitment is unknown.

Fisheries

General status

These species are caught in three types of fisheries. Most important is the beach seine fishery, which may contribute as much as 30% of total catch in some islands. Less important are the bait fisheries for small schooling clupeids and similar species listed above, and gillnet fisheries. Further details of the gear, fishing practices, and distribution of the catch in these fisheries throughout the Lesser Antilles is available in Mahon and Rosenberg (1988).

There are no data from which to evaluate trends in catches or abundance. Some islands, notably Grenada and Barbados, report declining trends based on qualitative information.

Current management

The only current management measures for coastal pelagics are restrictions on seine mesh-size in Saint Vincent, and on the hauling of ballahoo nets which may only be taken up onto boats. In that island there are traditional practices regulating access to the resource. The first boat in a bay on a given day is allowed to complete its set before the next boat begins to set. Such practices may exist elsewhere, and indicate that community based conservation and management may be worth pursuing.

Population biology

Halfbeaks, hemiramphids, ballyhoo

The three species of halfbeaks (Hemiramphus balao, Hemiramphus brasiliensis and Hyporhamphus unifasciatus) in the eastern Caribbean are all

inshore, surface dwelling, schooling fish. They are usually caught with large beach seines. Most species have planktonic eggs and larvae, but detailed information is unavailable. H. brasiliensis, or ballyhoo, is the most common halfbeak in the Caribbean and off the Florida Coast. This species reportedly migrates northward in summer, along the eastern coast of the USA as far north as Massachusetts.

Seasonality of the fisheries in the Lesser Antilles indicates that ballyhoo migrate away from islands, or are otherwise unavailable during the summer. In the 1940s, ballyhoo were reportedly fished year-round in Saint Christopher but were most plentiful in October and December. Similarly, in Dominica, the best season for catching ballyhoo was September to November.

Carangidae: jacks, runners, scads, pompanos, and related species

Carangids are a circumtropical family of characteristically schooling, fast swimming, pelagic fishes. Some of the larger species are taken trolling offshore. These are the species for which most information is available. However, in the Lesser Antilles, jacks are most important in terms of their contribution to the seine catch. Most carangids apparently spawn offshore throughout the year.

Assessment and management

There has been no assessment of coastal pelagic species in the eastern Caribbean. There has been considerable research on Sardinella aurita in Venezuela, where it supports a large seine fishery, but this species is not common in the Lesser Antilles.

There do not appear to be significant stocks of any herring or herring-like fishes (Clupeaformes) in the Lesser Antilles. The abundance of the other coastal pelagics which are caught by beach seines is unknown. The relatively low total revenue from these fisheries in the region will probably preclude any intensive assessment program in the foreseeable future.

Although intensive application of standard survey and assessment techniques will probably not be feasible for these fisheries, there are several simple steps which could be taken to develop a minimum acceptable level of basic information. Catch and effort data will be of primary importance in assessing the status of these resources. This should include data on the relative importance of species in the catch, and on the seasonality of the catches of the various species.

Sampling for size composition of the catch by species would indicate the extent to which the catch consists of immature individuals. By comparing the mean size of fish in the catch to known growth curves, and to observed maximum sizes of individuals of the same species, it is possible to assess the extent to which growth overfishing may be occurring.

Habitats

Although there are no data on habitat use by coastal pelagics, it is probably safe to assume that degradation and destruction of coastal habitats will affect their distribution and availability to the fishery. In addition, many inshore habitats are nursery areas for the young of these species.

MANAGEMENT OPTIONS FOR SHARKS AND RAYS

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MANAGEMENT PLAN

Introduction

Sharks and rays are a component of the fisheries treated under four other plans: shallow shelf, reef fishes; deep slope and bank fishes; and large pelagics both oceanwide and contained within the Lesser Antilles. They are treated separately here because of certain distinctive characteristics, and because of a recent emphasis on improved fishing methods for sharks in Trinidad and Tobago, and Dominica. Close monitoring of the contribution of sharks to the catch in the other fisheries could indicate if a targeted fishery is warranted.

Sharks differ from other fishes in that they are generally large, long-lived and have low fecundity. This combination of characteristics makes them susceptible to overexploitation at relatively low fishing mortalities. The biology of sharks is relatively poorly known. The fact that shark is not a preferred fish among consumers in the eastern Caribbean region, has deterred investment in fisheries specifically for sharks. However, with special programs to educate consumers in ways of preparing this low priced commodity, increased targeting for shark may be expected.

Management objectives

The objective should be to exploit this resource as a source of food while ensuring that it is not overfished.

Problems for resolution

The initial problems will be ones of development: determining if the resource is sufficiently large to be worth targeting; and overcoming consumer reluctance to eat shark.

There is a lack of information on current catches, and on the fishery biology of sharks on which to base a management strategy.

Management unit

For demersal sharks, the management unit could first be taken as the island shelf. Some pelagic sharks are known to range throughout the Atlantic ocean, whereas others are probably more coastal and will likely be restricted to the Lesser Antilles region. There is not much information from this region, and relevant information from other regions has not been compiled with the fisheries of this region in mind.

Current regulations

There are no current regulations for shark fisheries.

Management options

1. No action

If shark fishing is allowed to develop uncontrolled and unmonitored, the resource will eventually become depleted. It is not possible to estimate how long this may take.

2. Other options

Any discussion of specific options for shark fisheries would be premature at this stage of development of the fisheries. Those species taken as bycatch in the demersal and pelagic fisheries covered under other plans would be included in their management. The purpose here is to focus briefly on the likelihood that a separate plan will be needed if specific fisheries for shark develop.

At this point the main requirement would be monitoring of catch, effort and size data as the fisheries develop. Data on size at maturity should be collected whenever possible.

Action summary

Short term (1-3 years)

Monitoring systems for catch, effort, and size data should be established and should be certain to record information for sharks separately, particularly where they are targeted species.

SUPPORTING MATERIAL

The information here is taken from reports of Kleijn (1974) and Springer (1979), and a review book by Castro (1983). Note that most of the information on sharks in the eastern Caribbean is based on longline catches. This gear may exploit different species to those commonly taken by surface trolling as practiced by the multispecies pelagic fisheries of the Lesser Antilles.

No sources for rays could be found which specifically referred to the eastern Caribbean.

Species composition

There are about 11 species of pelagic sharks commonly taken by longline and troll fishing in the eastern Caribbean. There are no data on species composition of demersal shark catches, but nurse sharks are considered to be the most common species taken.

Stock structure

Very little is known about the stock structure of shark populations. Considering the diversity of life history and habitat types in this heterogeneous group, the full range, from local, shelf specific, to ocean wide stock distribution is probably represented.

Long migrations are characteristic of several large species, such as the blue shark (Prionace glauca) and tiger shark (Galeocerdo cuvieri). For example blue sharks from New England have been recaptured in northeastern South America and also across the Atlantic. Many of the smaller species, and some larger ones with habitat restrictions, may migrate only inshore-offshore.

Fisheries

In the eastern Caribbean, sharks are caught incidentally to trolling for offshore pelagics, and sharks and rays are caught occasionally in trap and handline fisheries on the island shelves. In the latter case the species is usually the nurse shark.

In the eastern Caribbean, pelagic sharks are caught mainly with line gear, in artisanal fisheries and by sportfishermen. However, it is necessary to gather information on the identities, life-histories, distribution and abundance of shark species in the area, especially in the Lesser Antilles, since little is available.

Current management

There are no regulations controlling the harvesting of sharks in the eastern Caribbean.

Biology and management

Some facts about the sharks of medium and large size which are important for shark fishing and management are that: they grow slowly, have long life spans, and have relatively low fecundity. This combination of life-history traits would make them susceptible to overfishing.

MANAGEMENT OPTIONS FOR SEA TURTLES

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Problems for resolution	Assessment and management
Management unit	Habitats
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MANAGEMENT PLAN FOR TURTLES

Introduction

Marine turtle populations in the western Atlantic are considered to be severely overexploited, and in some cases threatened with extinction. Despite widespread efforts to reduce exploitation, fishing continues in most islands of the Lesser Antilles.

Management objectives

The objective should be to rehabilitate sea turtle populations to levels where they can be safely exploited for sustained yields.

Problems for resolution

Enforcement of current regulations is the major problem to be solved in turtle conservation and rehabilitation efforts.

Conservation of appropriate nesting beaches is of critical importance.

Monitoring the response of the populations to the above measures will require special programmes.

Management unit

The appropriate unit for management varies with the species, but in all cases should be at least the wider Caribbean.

Current regulations

Current regulations include a closed season in most countries during the nesting period (March-July), and minimum size or weight limits. Taking eggs from, or disturbing nests is prohibited. In some countries turtles cannot be taken within 100 yards of shore. In several islands, the sale of turtle shell products is prohibited.

Management options and implications

1. No action

Under this option, sea turtle populations can be expected to remain at very low levels and certain species may become extinct.

2. Other measures

It is probable that enforcement of current and proposed regulations will provide adequate protection for sea turtle populations which should recover to exploitable levels. This recovery will probably be slow owing to the population characteristics of these species. The moratorium on fishing may result in hardship due to displacement of fishermen. This should be addressed with alternative employment programmes. Net buy-back programmes may serve to reduce the impact on fishermen.

Habitat conservation

The degradation and destruction of nesting beaches due to coastal development is perhaps the major threat to sea turtle populations. The severity of this problem varies with the species.

Action summary

Short term (1-3 years)

Current and proposed regulations would have to be rigorously enforced. Where resources permit, beaches should be monitored for nesting activity in order to detect changes in populations. Minimal monitoring could involve covering selected beaches every 2-3 years.

The public, particularly in coastal areas, should be educated as to the status of turtles and what they can do to contribute to turtle conservation and stock rebuilding. For example, public cooperation in terms of refusal to purchase turtle shell products, reporting of nesting events, reduction of beach lighting during the hatching season, and assistance to disoriented hatchlings, would be valuable.

Medium to long-term (3-10 years)

As turtle populations rebuild, it will be necessary to devise a strategy for conservative harvesting, based on estimates of growth, mortality and reproductive rates.

SUPPORTING MATERIAL

Species composition

The four common species of marine turtles are:

leatherback	<u>Dermochelys coriacea</u>
green	<u>Chelonia mydas</u>
hawksbill	<u>Eretmochelys imbricata</u>
loggerhead	<u>Caretta caretta</u>

Fisheries

Despite the moratorium called for by the OECS harmonized regulations, turtles are regularly harvested in most eastern Caribbean islands. The catch is almost entirely green and hawksbill turtles. They are most often taken by turtle nets (large-mesh tangle nets), spearguns, and on beaches while nesting. The flesh is eaten and the shells are sold. Turtle eggs are also taken from nests for human consumption.

Biology and management

Sea turtles are long-lived and very late maturing relative to most other exploited marine resources (except whales). They nest on beaches so the eggs and hatchlings are vulnerable to a variety of predators.

There is no stock assessment in the usual sense for any species of turtle. Most research efforts have been oriented toward conservation and acquiring the basic information required for conservation and rehabilitation.

Monitoring the rate of rebuilding of the populations will provide vital information for determining potential yields. This activity is being coordinated by the Organizational Committee for the Western Atlantic Turtle Symposia. A critical question for the long term management of turtles is whether females return to their natal beaches to lay their eggs. If so, assuming that open ocean fishing is negligible, individual island could manage their turtle populations independently of their neighbours.

Assuming that fishing is successfully curtailed, there will be no catch to monitor. However, the recovery of the populations should be monitored. This would be most easily done by monitoring nesting frequency throughout the region. Techniques and methods for such monitoring are outlined by the Western Atlantic Turtle Symposium (WATS) (1983). Increased public awareness, and participation of natural history organisations and schools may be appropriate ways of monitoring turtles without much investment.

Habitats

Marine turtle populations are particularly dependent on appropriate beach sites for nesting. Coastal development has had a tremendous impact on the availability of suitable beaches for nesting. These impacts range from total destruction due to coastal structures, through disturbance of turtles in the act of nesting, to disorientation of hatchlings by artificial lighting. Conservation of suitable beaches is therefore of vital importance.

The organization which has been most active in Turtle conservation and management in the western Atlantic is the WATS. More recently, WIDECAST (the Wider Caribbean Sea Turtle Network) has been coordinating conservation activities.

MANAGEMENT OPTIONS FOR SEA URCHINS

CONTENTS

MANAGEMENT PLAN	SUPPORTING MATERIAL
Introduction	Species composition
Management objectives	Stock structure
Problems for resolution	Fisheries
Management unit	Biology and management
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MANAGEMENT PLAN

Introduction

Sea urchins support small-scale fisheries in several southern Lesser Antillean islands. The gonads are a consumer delicacy in some islands, notably Barbados, Saint Lucia and Martinique. They also fetch high prices as sushi in metropolitan centres and especially in Japan. Extraregional export markets have not been explored. All the production from the Lesser Antilles could probably be consumed within the region, but export markets could be more lucrative.

Management objectives

The objectives should be to optimize the yields of sea urchin gonads from coastal waters while ensuring that the resource is not overexploited.

Problems for resolution

Several islands with urchin stocks do not have fisheries, probably because urchins are not a traditional food and export markets remain undeveloped.

Given the demonstrated ease of overexploitation of sea urchins, means of controlling the amount of catch are needed.

Management unit

For most management, the island shelf will be the appropriate management unit for sea urchins. Where two or more States share a single shelf, joint management is indicated. Owing to planktonic dispersal of eggs and larvae, overfishing in one area may affect recruitment to fished stocks in a neighbouring area. Thus, local regulations may have regional implications.

Current regulations

There is a fixed closed season in Barbados, whereas in Saint Lucia, fishing permission is at the discretion of the Fisheries Officer, and is used to effect a closed season.

Management options and implications

1. No action

As new sea urchin fisheries develop, the pattern of overexploitation seen in Barbados is likely to be repeated. If export markets for the fresh product are developed, its high value could rapidly escalate fishing pressure on the resource, leading to more rapid overexploitation than in Barbados where the catch is consumed locally. It would be dangerous to develop fisheries for export markets without mechanisms for controlling exploitation.

2. Other approaches

In theory, most management methods could be considered for sea urchins, but the major question is "What level of management is justified by the total value of the resource?". There is no good information on the potential yield per unit shelf area on which to base a management strategy.

Size limits could be used to prevent recruitment overfishing, and maximizing yield/recruit. However, given the small-scale nature of the fishery, enforcement will be difficult. Since the fishery is single species, there may be some potential in a direct limited entry approach in which certain fishermen are licensed to harvest sea urchins. The desired level of effort could be achieved through licensing all current fishermen and subsequent attrition.

Since urchins are harvested at about one year old, a closed season could be used to regulate the minimum size taken. The fishery could be opened only when the urchins are at an appropriate size. This approach could also be used to ensure that a minimum amount of spawning takes place before harvesting begins.

The possibility of allocating user rights to groups of fishermen to harvest from specific areas should be seriously considered. It would then be in their interest to ensure that the resource was not overexploited. Further information on fishing patterns and the attitudes of fishermen will be required in order to evaluate the feasibility of this option.

Habitat conservation

Sea urchins inhabit coastal areas which are subject to destruction and degradation by coastal development, and to land-based effluents. Conservation of coastal habitats is an important component of sea urchin fishery management.

Action summary

Short term (1-3 years)

Develop fisheries and markets, both local and export, in those islands where none exist.

Explore the feasibility of community-based fishing rights to areas.

Medium to long term (3-10 years)

Attempt to derive rough estimates of potential yield per unit area for sea urchins and to map suitable habitats in islands where there are fisheries, or where there are plans to develop fisheries.

SUPPORTING MATERIAL

Species composition

In the Caribbean, only one species, Trypneustes ventricosus, is currently harvested.

Stock structure

There are no studies of stock structure of this species, or of the extent of egg and larval dispersal between islands. Adults are clearly restricted to island platforms and probably spend their entire lives within a radius of 1 km. However, there is the potential for genetic mixing, and recruitment interdependence among islands due to planktonic dispersal of early life-history stages.

Fisheries

Sea urchin fishing is artisanal, primarily close to shore by skin divers, and requires minimal investment. Sea urchin gonads are a delicacy in Barbados and are in great demand. Owing to limited amounts of suitable habitat, sea urchin stocks are unlikely to be large enough to sustain extensive fisheries, and will be easily overfished. Therefore, management should aim at conserving the resource and the nature of the fishery. At present the status of this resource is: overexploited in Barbados, showing signs of overexploitation in Saint Lucia, lightly exploited in Grenada, occasionally exploited in Saint Vincent and the Grenadines, and unexploited in northern islands. Exploitation should be encouraged in islands where this resource is currently under-exploited. Given the sedentary nature of adults, a likely characteristic of these fisheries is localized depletion. Therefore, the rate of development and spatial distribution of new fishing effort should be monitored.

Only Barbados has regulations controlling the harvesting of sea urchins. There is a closed season from May to August each year. Recently there has been a two year moratorium on harvesting and the population is under surveillance to determine the impact of this measure.

Biology and management

Sea urchin, eggs and larvae are planktonic for several weeks during which the extent of dispersal is unknown. The adults are sedentary in a relatively narrow range of nearshore habitats, and are harvestable as they become sexually mature, at about one year. Longevity appears to be 3-4 years in unexploited stocks.

As with other single species resources, the full range of assessment techniques is theoretically applicable to sea urchins. The major question is what would be the appropriate means of managing this fishery so as to prevent overexploitation. Clearly, the resource, although valuable, is not sufficiently large to warrant extensive ongoing assessment or surveillance. Therefore, community involvement in management should be explored. This could take the form of fishing group (community/cooperative) rights to, or lease of, areas of shelf.

Even with community based management, some estimation of the potential yield from an habitat would be an important contribution to the fishing strategy of the group which had been allocated or leased territorial rights. Without this input the group would have to arrive at appropriate exploitation rates by trial and error. As indicated above the inputs could be based on several assessment techniques.

Active development of fisheries on previously unexploited resources would provide a unique opportunity to evaluate the effects of exploitation on the sea urchin populations.

Growth overfishing and yield/recruit

The parameters for yield per recruit analysis, growth, mortality, age/size at recruitment, can be estimated, and such analysis could contribute to size limits, or effort limitation.

Recruitment overfishing

Unquantified observation suggests that sea urchin recruitment is highly variable. There are no studies which indicate any relationship between the availability of recruits for settlement and the size of the parent stock. It is possible that juveniles prefer to settle in areas where adults are already established (W. Hunte, pers. comm.). Thus although recruitment overfishing may not occur in the usual sense, depletion of adult stocks may inhibit settlement. Transplant studies are in progress to resolve this question.

Potential yield

Survey estimates of biomass and recruitment are feasible for this species. Thus with mapping of suitable adult habitat for an island, potential yield could be estimated, and revised annually based on rapid surveys of the strength of the incoming yearclass. Again the costs of these approaches must be weighed against the value of the resource.

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APPENDIX 1

Preliminary Estimates of Potential Yield from the Waters of Lesser Antillean Islands

DEMERSAL RESOURCES

A preliminary attempt to calculate potential yields of demersal resources in the Lesser Antilles has been made by multiplying areas and perimeter distances of island platforms and banks by various estimates of yield per unit area or length (Table 1). These estimates are very rough, and could be out by an order of magnitude. The purpose of including them here is to give some indication of the probable value of these resources, and a rough index of their potential for development.

The estimates for coral reef fishes have been compiled from many different areas by Marten and Polovina (1982). Most estimates fall within an order of magnitude range of 0.5-5.0 t/km²/year. Although much of this variability is probably due to real differences in productivity within habitats, or in proportions of different habitats, the authors warn that there are differences in the level of exploitation and in the species included in the estimates. For example they often include coastal pelagic species such as jacks and barracuda. There are some much higher estimates in the order of 18 t, but these are probably inappropriate for application over so large a geographic area.

The lower estimate of deep slope fish yield is based on an assessment of an unexploited resource in the Marianas Archipelago. Inasmuch as these islands are at a similar latitude to the Lesser Antilles, the result may be applicable. Although West Pacific fish assemblages are generally more diverse than those of the Caribbean, most of the catch in the Marianas consisted of 3-4 snapper/grouper species and a carangid. This is also usually the case in the Caribbean. The higher estimate of potential yield is by Munro (1977), and is based on observed catches from the Pedro Bank area off Jamaica.

The estimates for lobster were taken from Olsen (1983) whose figure was based on work in the USVI. Conch yield estimates presented by Appeldoorn (1987) ranged from 0.03-0.1 t/km²/year. Those for the USVI, about 0.06 t/km²/year, were applied in Table 2.

Whereas these various estimates may give some idea of the total yield, and thus value, of a resource for the entire region, they should not be used on a finer geographic scale for island specific planning. At the regional level, differences due to habitat composition should cancel out to some extent, whereas at the island level, this source of error could be substantial. Even so, there are some gross indications of mismatch in potential yield and reported landings, particularly for the Grenadine Bank, where it appears that conch and lobster landings are an order of magnitude less than the estimated yield. This could be due to severe depletion of the resources, and indicates the possible benefits of management and rehabilitation.

PELAGIC RESOURCES

Oceanwide pelagics

Until the ICCAT databases become adequate for general production or sequential population analysis, estimates of potential yield can only be of the roughest type, based on observed yields from intensely fished ocean and near island habitats in other tropical regions. Marcille (1985) has attempted such an estimation procedure for two relevant areas: the southern Lesser Antilles, together with Trinidad and eastern Venezuela; and the northern Lesser Antilles including eastern Puerto Rico. These estimates, which are for oceanwide species such as yellowfin and skipjack tuna, are based on observed yields (per one degree square of ocean) of such species from other areas of the tropical Atlantic. A potential yield value of 660 t/year/degree square has been postulated for a rich intensely exploited oceanic zone, with a minimum of 100 t/year/degree square. The larger value was applied to the southern Lesser Antilles/Trinidad/Venezuela, whereas the lower value was considered appropriate for the northern Lesser Antilles/Puerto Rico zone. In each zone, squares with coastal influences were assumed to have a potential yield of 1 200 t/year, a value approximating the coastal zone of Senegal.

The potential yield estimated for the northern zone was about 14 000 t/year, while the estimate for the southern zone was 20 000 t/year. These estimates could be recalculated to apply to the EEZs of the Lesser Antilles, and together with estimates of fishing capacity would give at least a first approximation of a target fleet size for development purposes. There are several reasons why these estimates may be inappropriate. For example oceanic productivity off West Africa is enhanced by upwelling, and there are no major areas of upwelling in this region. This may be partly compensated by the nutrient output of the big South American Rivers, but the extent to which this occurs, and how far into the Lesser Antilles any such influence extends, is unknown. It certainly seems unlikely that coastal influences of the northern Lesser Antillean islands, with minimal runoff, can be of similar magnitude to those off West Africa. Thus the figure of 1 200 t/year/degree square may be too high.

Marcille's (1985) warnings about his estimates should be taken very seriously. He notes that these yields can only be achieved at very high fishing effort, when catch per unit effort is relatively low. He also advises that the target yield be set at 75% of his estimates, and that catch rates be monitored very closely as fishing effort increases.

Regional pelagics

Without better information on stock structure, and catches, estimates of potential yield can only be of the roughest type, based on observed yields from intensely fished ocean and near island habitats in other tropical regions. Marcille (1985) has attempted such an estimation procedure for the Lesser Antilles by extrapolating catches in those islands with pelagic fisheries to those with none. On the basis of comparison with catch per unit shoreline in other parts of the Atlantic he adjusts the total upwards slightly, with due consideration for low productivity due to nutrient limitation in the Lesser Antilles. He estimates a production potential of 6 000-7 000 t of small tunalike species, not including dolphin. This he compares to the 1985 reported catches of 2 000-4 000 t.

On the basis of these estimates one could envisage increases in landings of about 50-80% above 1985 levels in islands with pelagic fisheries, and expansion to similar levels in those islands which do not currently harvest pelagics. However, more detailed rough estimates of this type should be carried out to establish the likely range of potential yield which could be expected. Such estimates would involve substantial compilation of data from similar habitats in other parts of the world, and will in themselves require considerable investment in time, and possibly travel.

Table 1

Areas and length of slope (100 fath or 200 m contour) for shelves and banks in the Lesser Antilles

Shelf or Bank	Shelf				Slope				Lobster		Conch	
	Area (km ²)	Yield (t/yr)		Catch (t/yr)	Length (km)	Yield (t/yr)		Catch (t/yr)	Yield (t/yr)	Catch (t/yr)	Yield (t/yr)	Catch (t/yr)
		Total	Min.			Total	Min.					
BVI shelf	3 133	1 567	15 665		176	25	111		157		188	
Anguilla total	2 392	1 196	11 960		170	24	107		120	128	144	24
Anguilla shelf					124							
Bank E	2 208				16							
Sombbrero Bank	41				30							
2 Banks N and NE	82											
Bank SE	41											
Saba total	1 713	857	8 565		237	33	149		86	5	103	
Saba shelf	20				24							
Saba Bank	1 667				173							
Bank N of Saba	26				40							
St. Eustatius	113	57	565		46	6	29		6		7	
St. Maarten	50	25	250		10	1	6		3		3	
St. Martin and Barthelemy	1 660	830	8 300		152	21	96		83		100	
St. Chris. and Nevis total	845	423	4 225		178	25	112		42	17	51	
St. Chris. and Nevis shelf	595				156							
Anguilla shelf (piece)	250				22							
Antigua and Barbuda total	3 568	1 784	17 840		393	55	248		178	50	214	
Antigua and Barbuda shelf					264							
Bank S.	40				20							
Anguilla shelf (piece)	7				23							
Redondo shelf	98				62							
Havers Shoal	5				8							
St. Chris./N shelf (piece)	18				16							
Montserrat total	146	73	730		123	17	77		7	0	9	10
Montserrat shelf	106				53							
Bank SW	40				20							
Long bank SE	80				50							

Table 1 (Continued)

Shelf or Bank	Shelf				Slope				Lobster			
	Area (km ²)		Yield (t/yr)		Length (km)		Yield (t/yr)		Catch (t/yr)		Yield (t/yr)	
	Parts	Total	Min.	Max.	Parts	Total	Min.	Max.	Parts	Total	Min.	Max.
Guadeloupe total	1 323	1 649	825	8 245								
Guadeloupe shelf	101				300	511	72	322				
Marie Gallante shelf	40				58							
Bank E	117				20							
3 Banks N	40				90							
Bank W	28				20							
Bank between Guad. & MG					23							
Dominica total	251	303	152	1 515	126	146	20	92	15	0	18	10
Dominica shelf	52				20							
Bank SE (part)	914	1 013	507	5 065	171	219	31	138	51	100	61	50
Martinique total	47				28							
Martinique shelf	52				20							
Bank NE												
Bank NE (part)	407	522	261	2 610	136	144	20	91	26	9	31	
St. Lucia total	7				8							
St. Lucia shelf	6				8							
Bank NE												
Bank S												
Barbados total	230	277	139	1 385	98	127	18	80	14	1	17	
Barbados shelf	47				29							
Bank SE												
St. Vincent total	111	1 800	900	9 000	80	228	32	144	90	14	108	5
St. Vincent shelf	1 689				148							
Grenadine Bank												
Grenada shelf		1 595	798	7 975		231	32	146	80	3	96	10
Total		20 779	10 390	103 895		3 091	433	1 947	1 039	427	1247	409

Shelf yield based on a range of 0.5-5.0 t/km²/year

Minimum slope yield based on Polovina's estimate of 222 kg/nmi²/year

Maximum slope yield based on Olsen's estimate of 2 760 lb/km²/year

Lobster yield based on estimate of 0.05 t/km²/year (QPMC, 1984; Olsen, 1984)

Conch yield based on estimate of about 0.06 t/km²/year (Appeldoorn, 1988, 1984; Olsen, 1984)

SECTION II: REPORT OF THE WORKSHOP ON FISHERY MANAGEMENT PLANNING FOR THE LESSER ANTILLES (FAO/TCP/RLA/6776)

(Holetown, Barbados, 21-24 November 1988)

OPENING

The workshop was chaired by Mr. Patrick McConney, Fisheries Officer, Barbados. Drs R. Mahon, FAO, and Wayne Hunte, Bellairs Research Institute were rapporteurs. The Chairman welcomed participants (Appendix 1), and presented the Agenda (Appendix 2) for approval. The meeting then reviewed the background and rationale for the meeting.

The project was conceived to assist the OECS Fishery Unit in its mandate to develop fishery management plans for Member States and for the OECS region. These Fishery Management Plans are required by the harmonized legislation, which has now been enacted in all States. Barbados, which is also a participant in the project, is in the process of enacting similar legislation. Barbados and the OECS States have similar or shared resources and similar management requirements. The work being done in this project is expected to be useful and applicable elsewhere in the Lesser Antilles, and even in the wider Caribbean.

The Fishery Management Plans which are being developed in this project are valuable for several reasons:

- (1) They provide an important point of reference for continuity in a changeable political and administrative environment.
- (2) Their preparation and review involves considerable discussion and explanation.
- (3) They provide a way of informing local and international agencies of the status and direction of fisheries management, thus indicating where they can contribute, and how they can harmonize their activities with fisheries objectives.

The objectives of the meeting were reviewed with reference to the Project Workplan and the following agreed upon:

- To establish the position of each country regarding the Management Options presented, and the recommended action for each resource.
- To identify those areas which require a regional approach.
- To consider ways in which country plans may contribute to or constrain a regional approach.
- To consider and recommend a course of action, and regional mechanisms for finalizing and implementing the plans.

STATUS OF FISHERY MANAGEMENT PLANNING

The meeting then reviewed the status of fishery management planning in participating countries.

Antigua and Barbuda: There is no FMP, although management related activities are underway. A management and development policy paper is being prepared for consideration by the Fishery Advisory Committee which is in place, and has been active over the past three years.

Barbados: There is no FMP, but there is a development plan. Considering the recent infrastructural developments in Barbados, there is a perceived need for an FMP Dominica. There has been a preliminary management plan since 1987. However, this is awaiting the results of the present project for finalization.

Grenada: There is a document setting out broad management principles for this country. However, there is no detailed plan. The Fisheries Advisory Committee is in place and has begun its activities.

Saint Christopher and Nevis: Although there is a five-year development plan, it is project oriented rather than comprehensive. The preparation of a plan outlining a coordinated approach to Fishery Management is seen as a priority activity.

Saint Lucia: There is a five-year development plan for fisheries but no FMP. However, management is a major component of the daily activities of the Fishery Management Unit. A FMP is expected to result from the deliberations of the current meeting.

Saint Vincent and the Grenadines: There is a 10-year development plan which does not specifically consider fishery management. Given anticipated developments, such as the Tobago Cays Marine Park, and the development of cooperatives, management is expected to increase in profile in the near future.

REVIEW OF MANAGEMENT PRINCIPLES AND OPTIONS

The meeting then proceeded to review the Management Options Document (Section I of this Report) with the meeting objectives in mind.

PART 1

The meeting recognized the implications for improved coastal state fishery management embodied in UNCLOS III.

The question of foreign access to surplus fish yields in EEZs was discussed in relation to the countries capability to carry out resource assessment.

The meeting accepted the basic guiding principles for fishery management. With reference to the objectives, it was noted that these were for illustrative purposes and were not intended to reflect suggested priorities for the region.

PART 2

The role of PART 2 as an introduction to fishery management concepts and tools was recognized. Necessary amendments are reflected in the revised document.

In particular, the meeting emphasized that there is often inconsistency in the use of the terms licensing and registration in this region. It was noted that registration is an information gathering tool aimed at maintaining

records of fishing units and ensuring that they meet certain criteria, whereas licensing is the granting of permission to fish and may be used to limit access to a fishery if necessary. Both tools may be used to generate revenue.

The meeting noted that the cost of monitoring is only recently becoming accepted as an essential basic expenditure which must be budgeted for if fishery management is to proceed beyond basic fishery administration. The OECS Fishery Unit has an ongoing Institutional Data Enhancement Project to establish a comprehensive microcomputerized fishery database system and data collection programmes for the OECS Member States. The project will strengthen the data management capabilities of the Unit, and of the Fishery Divisions in Member States. Some aspects of this programme also involve enhancement of data collection and management capabilities in Barbados. The success of these efforts was seen as being ultimately determined by the willingness of the countries to provide the necessary resources for basic monitoring.

With regard to the potential role of community based management, several countries expressed doubts as to the widespread applicability of communal property rights. Attention was drawn to the potential role of cooperatives, as a community based unit, in fishery management. This role was seen more as one of facilitating information transfer between fishery managers and fishermen, than as one of direct responsibility for management.

Owing to the difficulties in estimating and monitoring TACs, these were considered to be presently inappropriate for most of the fisheries of the region.

The meeting noted that ultimately limited entry would probably be required for effective rehabilitation of overexploited resources. However, the potential negative impact of depriving some fishermen of their means of livelihood was recognized, and the meeting emphasized that these impacts should be minimized. The proposed method of licensing all active fishermen and allowing the reduction of effort to take place through attrition, was considered to be an effective means of minimizing this impact.

PART 3

The resource specific management plans were reviewed. Modifications to the Management Options Document were suggested by the participants. These are reflected in the revised document. In the following sections, the suggested action for each resource type is summarized. Each section includes island specific variations from the prescribed action, and elaborates on action or problem areas which the meeting felt required special attention.

The meeting recommends the following management actions as appropriate for the specific fisheries.

Management action for spiny lobster

Short term (1-3 years)

Monitoring systems for catch, effort and length frequency data should be established immediately. Current regulations should be rigorously enforced, and the monitoring systems used to evaluate their impact. The Cuban experience with lobster indicates that these measures alone should provide significant increases in yield and size of lobster in the catch. In particular, the use of purchase slips in data collection, as described in Mahon and Rosenberg (1988), will facilitate the enforcement of current regulations.

Destructive fishing practices and gears (e.g., spearfishing, SCUBA) should be banned.

There should be increased efforts to mitigate destruction and degradation of coastal habitats for juveniles.

Long-term action

Depending on the availability of funds, action oriented toward long-term improvement of lobster management could be initiated immediately, or could be delayed pending some results from the short term action described above. It is possible that rigorous enforcement of existing regulations may produce adequate results. Therefore, further expenditure on lobster management may not be economically justifiable.

Activities oriented toward improvement of management in the long-term, could include:

1. Evaluation of suitable locations for community based management.
2. More precise estimates of size limits required to minimize growth overfishing and to increase reproductive capacity.
3. A program to estimate potential yield from island shelves.
4. Evaluation of the feasibility of using artificial habitats for juveniles to boost productivity in adult habitats.
5. Evaluation of the feasibility of ranching.

Issues arising and country specific considerations

As tourism has developed there has been a shift in emphasis in several countries away from export of lobsters, and toward ensuring adequate supply for the tourist industry.

There were no substantive differences among countries regarding the appropriate management action for this resource.

Management action for conch

Short term (1-3)

Catch, effort and size-frequency monitoring systems should be established immediately. Current regulations should be rigorously enforced, and the above monitoring systems used to evaluate their impact. In particular, the use of purchase slips in data collection, as described in Mahon and Rosenberg (1988), will facilitate the enforcement of current regulations.

Efforts to mitigate destruction and degradation of coastal habitats for juveniles should be increased.

Medium to long-term (3-10 years)

Action oriented toward long-term improvement of conch management could be initiated immediately. However, rigorous enforcement of existing regulations may produce adequate results. Therefore, further expenditure on conch management may not be economically justifiable.

Activities oriented toward improvement of management in the long-term, could include:

1. Evaluation of suitable locations for community based management.
2. More precise estimates of size limits required to minimize growth overfishing and to increase reproductive capacity.
3. A program to estimate potential yield from island shelves.

Issues arising and country specific considerations

There were no substantive differences among countries regarding the appropriate management action for this resource.

Management action for shallow shelf fishes

Short term (1-3 years)

Monitoring systems for catch, effort, species and size composition, should be established immediately.

The use of trammel and tangle nets should be prohibited because they are destructive.

The problem of ghost traps should be addressed by requiring that traps be equipped with a biodegradable panel.

Dynamiters should be prosecuted to the full extent of the law. Trap mesh size should be regulated at the current size or 1.5 in, whichever is greater.

Medium to long-term (3-10 years)

In islands where overexploitation is evident, licensing of fishermen should be considered and the reduction of effort allowed to take place through attrition.

Depending on the availability of funds, programmes to provide island specific estimates of the status of the resource, and of potential yield should be initiated.

Other relevant research would include: studies of size at maturity for common species; trap mesh selectivity studies; trial closure of the largest feasible areas for 3-5 years with close monitoring.

Issues arising and country specific considerations

Trap stealing was identified as a serious problem in several countries. Apart from the direct impact on the fisherman through loss of catch, and frequently of the trap, two indirect effects were noted. The first is the habitat destruction resulting from the use of grappling gear to recover traps set without buoys. The second is that stolen traps are usually discarded, thus contributing to the ghost trap problem.

The offense of stealing traps and their contents is only prosecutable under the regular criminal code. Consequently, the penalties are relatively minor. Legal avenues for rectifying this situation should be explored in order to provide greater protection for fishermen. Successful detection and prosecution in cases of trap theft would be greatly facilitated if traps were identifiable as to their owner by a system of marking.

The setting of traps without buoys should be discouraged wherever possible.

Trammel and/or tangle nets are used in many countries. These may be destructive to habitats in which they are set, and as they fish indiscriminately may catch juvenile fishes.

The possible role of artificial reefs as a management tool was raised. The question remains open as to whether these structures enhance productivity, or simply aggregate fish, making them more susceptible to overexploitation.

The meeting noted that most options presented for ongoing management were relevant to traps only. Among the options, only limited entry was seen as a means of controlling line fishing effort.

There were no substantive differences among countries regarding the appropriate management action for this resource

Management action for deep slopes and bank fishes

Short term action (1-3 years)

Policy decisions should be made regarding the nature of the development of fishing fleets and gear.

Monitoring systems for catch and effort data as well as for length frequency samples and species composition should be established immediately.

Current rough estimates of potential yield should be reviewed and revised in the light of information from similar habitats and assemblages elsewhere.

Medium to long term action (3-10 years)

Resource assessment activities should be undertaken with the aim of providing more accurate estimates of potential yield, and of the impacts of exploitation on reproductive potential.

Issues arising and country specific considerations

If the efficient exploitation of this resource requires a mix of artisanal and mechanized vessels, potential conflicts between these units will have to be addressed. Saint Christopher noted that this problem had occurred there. In Saint Lucia, this has been approached by excluding larger vessels from areas traditionally fished by artisanal fishermen. Antigua noted that owing to the distance of the slope from the island, they did not have this problem.

Grenada noted that active encouragement of certain gears, such as bottom longlines, which are used in the exploitation of these and deeper shelf resources could result in increased fishing pressure on shallow areas which are already overexploited.

Saint Lucia noted that owing to the apparent small size of this resource in that country, the emphasis was on supply to local restaurants rather than on export.

Dominica emphasized that their management objective for this resource was to maintain high employment levels.

Cautious development of this resource was considered to be an important issue given that the total resource in the region may not be large.

There were no substantive differences among countries regarding the appropriate management action for this resource.

Management action for large pelagics with stocks extending outside the Lesser Antilles Region

Management action for these resources should be regional.

Short term (1-3 years)

Countries should decide on a development policy for offshore pelagics: commercial, small-scale, recreational, or combinations thereof, including measures for resolving potential conflicts.

Monitoring systems for catch and effort data by species, as well as for length frequency samples should be established immediately. Representative(s) from regional institution(s) should be designated to participate in ICCAT activities. This would facilitate the exchange of information between the region and ICCAT, and provide the region with access to the current methodology for assessment and management of these species.

The current emphasis on reducing unpermitted fishing through regional cooperation in surveillance and enforcement should be continued.

The current preliminary estimates of potential yield should be reviewed and revised using all available information from tropical pelagic fisheries. This estimate should include upper and lower limits. The difference between this estimate and current catches would give some indication of the scope for development within the EEZs of the region.

Medium to long term (3-10 years)

Catch rates within the region should be used to evaluate the scope for further expansion. This should be viewed in the context of large scale assessment of stock status and potential carried out by ICCAT.

Issues arising and country specific considerations

There were no substantive differences among countries regarding the appropriate management action for this resource.

Management action for large pelagics with stocks contained within the Lesser Antilles Region

Management action for these resources should be regional.

Short term (1-3) years)

Islands should decide on a development policy for offshore pelagics: commercial, small-scale, recreational, or a combination thereof.

Monitoring systems for catch and effort data as well as for length frequency samples should be established immediately. This will provide: data on total catch, estimates of the equivalency of various fishing units, and baseline information against which to evaluate the impacts of increased exploitation.

The current rough estimates of potential yield should be reviewed and revised using all available data from tropical pelagic fisheries. This estimate should include upper and lower limits. The scope for expansion should be set as the difference between the current catch and the most reasonable estimate of potential yield. Safety margins should be considered.

Medium term (3-5 years)

The scope for expansion should be allocated among islands according to agreed principles. This allocation could take the form of a non-binding agreement in the first instance. This will give islands an indication of the extent of fleet expansion that would be reasonable. First estimates of vessel equivalency should be agreed upon among islands.

Long term (5-10 years)

Analysis of catch data for migratory patterns and effects of increased exploitation. Revision of estimates of potential yield and vessel equivalency.

Issues arising and country specific considerations

Countries differed in their views of the significance of recreational fishing as an earner of foreign exchange, and their positions regarding sportfishing should be reflected in their FMPs.

There were no substantive differences among countries regarding the appropriate management action for this resource.

Management action for flyingfish

Management action for this resource should be regional.

Short term (1-3 years)

Most short term activity will relate to the Eastern Caribbean Flyingfish Program (ECFP), for example, the establishment of monitoring systems for catch and effort data, and length frequency samples. The studies in progress include: tagging for migration and stock structure; surveys for distribution/abundance of early life-history stages; seasonal distribution, abundance and bionomics of adults and juveniles around Barbados; examination of fishing patterns and catch per unit effort as an index of abundance.

Participating countries should continue to develop a regional policy for the exploitation and management of flyingfish.

Medium-long term (3-10 years)

Future activities will largely be determined by the results of the ECFP.

Issues arising and country specific considerations

The meeting noted that flyingfish could be the first resource for which shared resource management negotiations could be undertaken. Therefore this is the resource for which shared resource management principles and mechanisms would first be put into action.

There were no substantive differences among countries regarding the appropriate management action for this resource.

Management action for coastal pelagics

Short term (1-3 years)

Monitoring systems for catch, effort, species composition and size frequency samples should be established immediately. Emphasis should be on obtaining data on trends in abundance, seasonality and possible migration. However, size data could be used for assessment of the numbers of immature individuals being caught.

Fishing practices and the attitudes of fishermen to community based management should be explored.

Medium to long term (3-10 years)

Further action would be based on results of short term action above.

Issues arising and country specific considerations

There were no substantive differences among countries regarding the appropriate management action for this resource.

Management action for sharks and rays

Short term (1-3 years)

Monitoring systems for catch, effort, and size data should be established and should be certain to record information for sharks separately, particularly where they are targeted species.

Issues arising and country specific considerations

There were no substantive differences among countries regarding the appropriate management action for this resource.

Management action for sea turtles

Short term (1-3 years)

Current regulations should be rigorously enforced. Where resources permit, beaches should be monitored for nesting activity in order to detect changes in populations. Minimal monitoring could involve covering selected beaches every 2-3 years.

The public, particularly in coastal areas, should be educated as to the status of turtles and what they can do to contribute to turtle conservation and stock rebuilding. For example, public cooperation in terms of refusal to purchase turtle shell products, reporting of nesting events, reduction of beach lighting during the hatching season, and assistance to disoriented hatchlings, would be valuable.

Medium to long-term (3-10 years)

As turtle populations rebuild, it will be necessary to devise a strategy for conservative harvesting, based on estimates of growth, mortality and reproductive rates.

Issues arising and country specific considerations

The OECS countries and Barbados have discussed the possibility of a moratorium, which some countries are considering implementing. Grenada is planning to establish a closed season during the leatherback nesting season. Antigua and Barbuda will continue to enforce a closed season, but considers a moratorium unnecessary at this time, since the turtle fishery is phasing out. Dominica noted that in some areas there is insufficient alternative employment for fishermen to allow closure of the turtle fishery. Saint Lucia is considering a net buy-back program.

Management action for sea urchins

Short term (1-3 years)

Develop fisheries and markets, both local and export, in those islands where none exist.

Explore the feasibility of community-based fishing rights to specific areas.

Medium to long-term (3-10 years)

Attempt to derive rough estimates of potential yield per unit area for sea urchins and to map suitable habitats in islands where there are fisheries, or where there are plans to develop fisheries.

Issues arising and country specific considerations

Dominica has placed a ban on exploitation of sea urchins and has no immediate plans to develop a fishery on this resource.

Apart from the above there were no substantive differences among countries regarding the appropriate management action for this resource.

GENERAL POINTS

Several topics were common to all or several of the resources.

Fishery Divisions

In order to adequately implement many of the recommended management actions, it will be necessary to strengthen existing fishery divisions with staffing and training.

The meeting recommended that the Fishery Division structure be explicitly included in the fishery development or management plans of each country. The plan should state and prioritize the projected activities of the Fishery Division and its personnel requirements over the planning period. This would make it clear which aspects of fishery management could be undertaken with the existing Fishery Division resources, and enable regional activities to better target aspects oriented toward Fishery Division strengthening.

The meeting also noted that Fishery Divisions are often part of a Ministry with primary responsibility for another sector (forestry, agriculture, education). For Fisheries Divisions to fulfill their mandate, better institutional arrangements which provide a greater degree of autonomy and more direct access to decision makers, are generally required. The best

way in which to achieve this aim will differ among countries, depending on the relative value of the fishery resources. In some countries, the appointment of a Director of Fisheries, with parallel responsibilities to a Director of Agriculture may be appropriate. In others, an Administrative Officer, Deputy Permanent Secretary, or Minister with special responsibility for fisheries may be called for. Some participants felt that as fisheries increase in profile, separate ministries for fisheries may be required in some countries.

Habitat use considerations

The management options document indicated that habitat protection should be a primary concern for all shelf resources. However, a detailed action plan for Fisheries Divisions with regard to environmental protection was outside the scope of the document. The meeting participants considered that environmental problems impacting on fisheries are of considerable significance and recommended that approaches to solving these problems should be explicitly developed and included in Fishery Management and Development Plans.

The meeting noted that the Fisheries Act explicitly states that Fisheries Divisions have responsibility for internal waters, namely swamps, mangrove areas and lagoons. Nonetheless, various types of coastal development are frequently undertaken without reference to the Fisheries Division. The problem is exacerbated by the large number of agencies with interests in and responsibility for coastal marine habitats (Fisheries, Port Authority, Tourism Development, Trade and Industry, Effluent Disposal, Health).

Concern was expressed that in certain areas there was conflict between marine recreational uses and fishing. It was felt that it may be necessary to prioritize areas for fishing in order to avoid such conflicts.

Boundary delimitation

The meeting noted that EEZs based on the equidistance principle could in several instances cut across banks or divide off small pieces of island platforms. The meeting recommended that wherever possible boundary delimitation should seek to minimize the need for multinational management of demersal resources resulting from the subdivision of banks and island platforms.

The meeting further recommended that the OECS Fishery Unit consider preparing a map of EEZs which reflects the OECS position, for use in fishery management and boundary delimitation.

REGIONAL ASPECTS OF FISHERY MANAGEMENT IN THE LESSER ANTILLES REGION

Most of the management action summarized above will have regional implications. For resources associated with island platforms the implications are similar. For the offshore pelagics there are significant differences in regional action requirements for the different groups of species.

Resources associated with islands platforms (lobster, conch, shelf fishes, slope and bank fishes, urchins)

Management units for resources associated with island platforms should be considered at two levels. The first level relates to the distribution of the

demersal juveniles and adults, and is therefore the island shelf. For most management measures, this will be the appropriate unit. Where two or more States share the same shelf, joint management is indicated. The second level relates to the likely interaction of demersal stocks through planktonic early life history stages. Therefore, owing to possible effects of overfishing in one area on recruitment to a neighbouring area, local relations may have regional implications.

Stocks which are shared will require cooperative management. Any island attempting to manage just its part of a shared stock will not have all the information required. Assessments using incomplete data could be erroneous and could lead to inappropriate regulations. Inequality in the management of a shared stock could result in the less well managed area 'siphoning off' the resource from the more restricted area. Thus, management of these stocks requires cooperation in data collection, stock assessment, problem solving, research, analysis and regulation.

Even where stocks within the eastern Caribbean region are not shared, there are regional implications for management. Regulations should be harmonized, as is largely the case for the OECS. The objective of harmonization is to minimize the problem of transfer of illegal catch from one country to another where it is legal. Efforts should be made to synchronize closed seasons, and further measures should also be harmonized. Widespread implementation of catch and effort monitoring throughout the region would provide the basis for estimation of potential yield by comparison of island shelves.

Offshore pelagic resources

Offshore resources may be shared either by being distributed across boundaries, or by migrating across them. Implementation of the management actions presented above will require a regional approach.

For those stocks which are primarily exploited outside the EEZs of the region, regional management action may consist only of the compilation and interpretation of regional catch, effort and related data, and of liaison with extraregional organizations such as ICCAT.

For those stocks which are exploited primarily within the region, full responsibility for shared stock management lies with the countries of the region. This will involve not only cooperation in monitoring, assessment, and regulation, but also resource allocation negotiations. Decisions may be required regarding whether participating islands should take their share of the resource in their own EEZ, or whether economic efficiency should be promoted by allowing all participants to fish in the areas of high abundance.

Other regional issues

Apart from the resource assessment and management aspects summarized above, many other fishery management issues could be profitably addressed at the regional level. The following two issues were raised at the meeting.

If the countries in the region pursue an active policy of commercial fleet development with a view to more efficient utilization of deep water and offshore resources, it may be appropriate to consider fleet development at the regional level. This approach would spread the capital costs of commercial fleet development among countries, and could promote efficient operation of these larger vessels by maximizing their area of operation.

Most aspects of offshore surveillance will be more efficiently conducted through regional cooperation. Most of the management action recommended for nearshore fisheries will require increased levels of surveillance. Regional surveillance efforts (Regional Security System) could contribute to local surveillance.

Regional mechanisms

In order to address the regional implications described above, regional mechanisms for management will be required. Such mechanisms should be able to fulfill the following functions:

- (1) Coordination of monitoring and surveillance.
- (2) Resource assessment, problem identification and problem solving.
- (3) Technical review and provision of advice.
- (4) Policy setting and decision making.

In defining such a mechanism the following should be considered:

- (1) Strengthening of local Fishery Division capability.
- (2) Regional self sufficiency in management through strengthening of regional institutions.
- (3) Capability for interacting with countries outside the region
- (4) Linkages to regional research institutions which could provide applied research capability and expertise.

Given the above criteria and considerations, a possible regional fishery management mechanism is depicted in Figure 1.

The meeting recommends that CARICOM and OECS actively pursue the definition and formal approval of regional mechanisms for management of shared resources.

FUTURE DIRECTIONS

The next steps in the Fishery Management Planning process of which this project is a part are:

- (1) Preparation and approval of country FMPs.
- (2) Consideration, revision and approval of regional Fishery Management action.

The meeting recommends that CARICOM and the OECS Fishery Unit consider means of providing assistance with the finalization of country FMPs. This could be achieved with expertise already available in the region. In view of the differences in state of preparation of the plans, and in establishment of FACs (Appendix 3), this would best be addressed on an country basis.

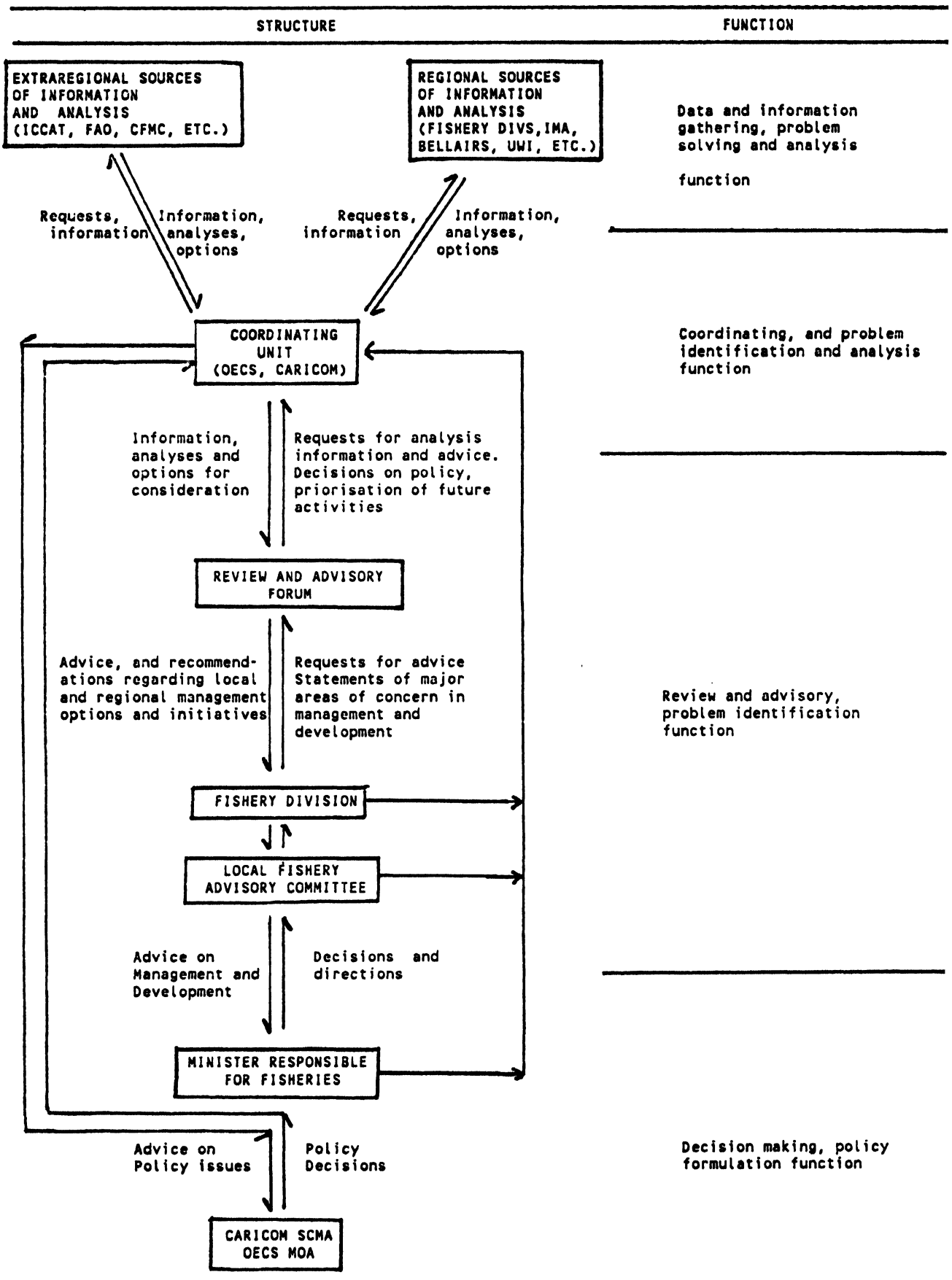


Figure 1. A possible mechanism for regional fishery management

APPENDIX 1

Participants

Antigua and Barbuda

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APPENDIX 2



联合国
粮食及
农业组织

FOOD AND
AGRICULTURE
ORGANIZATION
OF THE
UNITED NATIONS

ORGANISATION
DES NATIONS
UNIES POUR
L'ALIMENTATION
ET L'AGRICULTURE

ORGANIZACION
DE LAS NACIONES
UNIDAS PARA
LA AGRICULTURA
Y LA ALIMENTACION

منظمة
الغذية
والزراعة
للأمم
المتحدة

**Agenda for Final Workshop
(TCP/RLA/6776 Lesser Antilles Fishery Management Plan)**

Discovery Bay Hotel, Barbados, November 21-25th, 1988

Monday 21

Morning (09:00-12:00)

Opening
Election of Chairman
Review Agenda
Background and rationale
Review of Management Options
General Principles
Management approaches

Afternoon (13:30-17:00)

Review of Management Options
Lobster
Conch
Shallow shelf fishes

Tuesday

Morning

Review of Management Options
Slope and Bank
Oceanwide pelagics

Afternoon

Review of Management Options
Regional pelagics
Coastal pelagics

Wednesday

Morning

Review of Management Options
Flyingfish
Minor species

Afternoon

Review of regional implications
Future directions

Thursday

Morning

Report preparation

Afternoon

Review and approve report

APPENDIX 3

The Status of Fishery Advisory Committees in Participating Countries

Country	Status
Antigua and Barbuda	established
Barbados	considering
Dominica	soon to be established
Grenada	established
Saint Christopher and Nevis	considering
Saint Lucia	considering
Saint Vincent and the Grenadines	considering

The composition of the two FACs currently established varies slightly from that recommended by the harmonized regulations:

Grenada Fisheries Advisory Committee, Grenada Ministry of Education, Culture and Fisheries

Permanent Secretary	Chairman
Manager, Artisanal Development Project	Deputy Chairman
Chief Fisheries Officer	Secretary
Soubise Fishermen's Association	Representative
Saint John's Fishermen's Association	Representative
Saint Mark's Fishermen's Association	Representative
Sauteurs, Saint Patricks Fishermen's Group	Representative
Saint Georges, Grand Mal Fishermen's Group	Representative
Saint Davids, Mahout Fishermen's Group	Representative

Any other members ex officio thought to be needed for the meeting, e.g., Coast Guard, Cooperatives Registrar.